PREFEASIBILITY STUDY
OF HYDROELECTRIC POWER GENERATION
AT VERMILION FALLS, ALTA.

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Near Fox Lake and John D'Or Prairie

Prepared for:

Alberta Power Limited

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With contributions from:

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Alberta Government's Department of Tourism and Small Business,
and
Remote Community Demonstration Program
of Energy, Mines and Resources Canada

March 1985

RCDP/PDCE-58

This report was prepared with contributions from Indian and Northern Affairs Canada and the Remote Community Demonstration Program of Energy, Mines and Resources Canada (EMR). Distribution of this report by EMR does not necessarily signify that the contents reflect the views and policies of either department. Mention of trade names and commercial products does not constitute recommendation or endorsement for use.

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ABSTRACT

The communities of Fox Lake and John D'Or Prairie currently are provided with electricity by separate diesel generating installations. The possibility of saving fuel and achieving cost savings by hydroelectric generation at Vermilion Chutes has been studied. A convenient location for installation of a power plant was identified and a preliminary design was proposed. It was found that ice jams form in the Peace River at this location and that the falls and rapids of Vermilion Chutes are flooded for the greatest part of each winter.

It has been concluded that hydroelectric development at this scale would not be economical at Vermilion Chutes.

EXECUTIVE SUMMARY

The Project

The Vermilion Chutes on the Peace River comprise a series of rapids with a total fall of approximately 3 m and Vermilion Falls which is located approximately one kilometer downstream. The study investigates the feasibility of developing a source of hydroelectric power at Vermilion Falls. The power generated would supply the nearby communities of Fox Lake and John D'Or Prairie. It would provide an alternative to the current dependency on diesel generation at both communities with its comparatively high operating costs and with the attendant uncertainty of escalating fuel prices.

The peak demands at Fox Lake and John D'Or Prairie were both estimated to be 215 kW in 1985. The loads are estimated to increase at an annual rate of just under 5 percent for the period of the study.

The most favorable site is located midway between the two communities. Approximately 4.5 m of head is available at the falls except when they are flooded during the winter due to river ice jamming downstream. It has been estimated that the head across the falls would be too little for turbine operation for about four months each winter. The existing diesel generators would be retained and operated during this period. The benefits of the hydroelectric development at this site are expressed by a reduction in the quantity of fuel required.

The Preliminary Design

A preliminary design has been proposed for a development on a rock ledge at the north and left side of the river adjacent to the falls. This location was chosen during a site reconnaisance visit.

The project envisaged would comprise an upstream rockfill groyne to divert 30 m^3/s of the river flows into a deepened approach channel leading to a power canal excavated through the rock ledge. The water would then pass through one or two horizontal axis Kaplan turbines and be discharged downstream of the falls via an excavated tailrace channel.

The rock excavated from the canal, powerhouse and tailrace would be used to construct the river diversion groyne and extend it to protect the powerhouse from impacting ice thrusts. The turbines would be set below the current rock surface elevation. The reinforced concrete powerhouse structure would be constructed as a open well to an elevation above the anticipated maximum ice level. From observations of ice scour of the left river bank, it is estimated that the top of the powerhouse substructure would have to be built 8 m above the existing rock surface.

During the eight months that the full 4.5 m head would be available, the powerplant could continuously supply 500 kW of electric power from each turbine. This power would be carried by new transmission lines to each community.

Estimated Costs

It is estimated that the project, including access roads and transmission lines, would cost approximately $6,400,000 and $8,700,000 for 500 kW and 1000 kW installations respectively serving both communities and approximately $6,000,000 for 500 kW serving only John D'Or Priarie. Access to the power site for construction and for operation and maintenance of the powerplant would represent a major capital cost component.

Economic Viability

The economic evaluation of the proposed project has been based upon the value of fuel replaced over 30 years. The requirement for supplementary power production during winter months makes it necessary to maintain the existing diesel power plants.

The base case considered was a 1000 kW installation serving both communities. This would result in savings in fuel oil consumption which are predicted to increase from 300 000 litres in the first year of operation to 1 000 000 litres in the 30th year. The value of the fuel saved over a 30 year period was compared with the estimated hydroelectric costs. This hydroelectric installation would be more expensive than continued diesel operation by more than 7 million dollars in present worth terms.

The sensitivity of this result to variations in the basic assumptions was tested. In all the sensitivity tests, including consideration of 12 month hydro operation, variation in discount rates, inflation rates, escalation in fuel prices, and plant capacity, the hydroelectric installation remained uneconomic. Even with the favourable assumptions, the hydroelectric development cost approximately $4 million more than diesel generation.

CONCLUSIONS

A hydroelectric development at Vermilion Falls to provide electric power to the communities of John D'Or Prairie and Fox Lake is technically feasible but the project would not eliminate the need for diesel generation and would not achieve sufficient fuel savings to be economically attractive.

RECOMMENDATIONS

It is considered that further study of the proposed small scale hydroelectric development potential at the Vermilion Falls site is not warranted.

ÉTUDE DE FAISABILITÉ D'UNE PETITE CENTRALE ÉLECTRIQUE AUX CHUTES VERMILION PRÈS DE FOX LAKE ET DE JOHN D'OR PRAIRIE (ALBERTA)

Résumé

Les chutes Vermilion sur la rivière de la Paix comprennent une série de rapides dont la hauteur totale de chute est d'environ 3 m et les chutes elles-mêmes qui sont situées à environ 1 kilomètre en aval. La faisabilité de l'aménagement d'une source de puissance hydro-électrique aux chutes Vermilion a été étudiée. La puissance produite approvisionnerait les localités de Fox Lake et de John D'Or Prairie situées dans le voisinage. Elle constituerait une solution de rechange à la dépendance actuelle à l'égard de la production d'électricité par génératrice diesel dans les deux localités, les coûts d'exploitation de ces génératrices étant relativement élevés et l'incertitude planant vis-à-vis d'une escalade des prix du carburant.

On a évalué à 215 kW, la demande de pointe à Fox Lake et à John D'Or Prairie en 1985. Cette demande devrait s'accroître d'un peu moins de 5% par année pendant la période faisant l'objet de l'étude.

L'emplacement le plus favorable est situé à mi-chemin entre les deux localités. Une hauteur de chute d'environ 4,5 m disponible aux chutes, sauf lorsqu'elles sont inondées en hiver en raison de l'embâcle de la rivière en aval. On a estimé que la hauteur de chute serait trop faible pendant environ quatre mois chaque hiver pour pouvoir faire fonctionner des turbines. Les génératrices diesel existantes seraient conservées et continueraient à fonctionner pendant cette période. Les avantages de l'aménagement hydro-électrique sur le site se traduiraient par une réduction de la quantité de carburant requise.

Des études techniques préliminaires ont été proposées pour un aménagement sur une saillie rocheuse sur la rive nord et gauche de la rivière à proximité des chutes. Cet emplacement a été choisi pendant une visite de reconnaissance du site.

Le projet envisagé comprendrait un épi en enrochements qui servirait à dériver 30 m^3/s du débit de la rivière dans un canal d'amenée surcreusé aboutissant à un canal d'énergie creusé dans la saillie rocheuse. L'eau passerait alors dans une ou deux turbines Kaplan à axe horizontal et serait déversée en aval des chutes par un canal d'évacuation creusé.

Les roches extraites du canal, de l'emplacement de la centrale électrique et du canal d'évacuation serviraient à construire l'épi de dérivation de la rivière et le prolongeraient pour protéger la centrale des poussées des glaces. Les turbines seraient installées au-dessous de la hauteur actuelle de la roche. La centrale électrique en béton armé serait construite sous forme de puits ouvert jusqu'à une hauteur supérieure au niveau maximal prévu des

glaces. D'après des observations de l'affouillement de la berge gauche de la rivière par les glaces, on estime que la partie supérieure de la structure de la centrale électrique devrait être construite jusqu'à une hauteur de 8 m au-dessus de la surface existante de la roche.

Pendant les huit mois de disponibilité de la hauteur de chute de 4,5 m, chacune des turbines de la centrale électrique pourrait continuer à fournir 500 kW d'énergie électrique. Cette puissance serait transportée par de nouvelles lignes de transport jusqu'à chaque localité.

L'accès à l'emplacement de la centrale électrique pour en assurer la construction, le fonctionnement et l'entretien représenterait une importante composante des coûts d'immobilisations. On estime que le projet, y compris les routes d'accès et les lignes de transport d'énergie, coûterait environ 6 400 000 et 8 700 000 $ respectivement pour des installations de 500 kW et de 1 000 kW desservant les deux localités et près de 6 000 000 $ pour des installations de 500 kW ne desservant que la localité de John D'Or Prairie.

La rentabilité économique du projet a été évaluée d'après la valeur de combustible remplacé sur une période de 30 ans. L'accroissement de la demande pendant les mois d'hiver oblige à conserver les génératrices actuelles.

Le projet de base envisagé comporte l'aménagement d'une centrale de 1 000 kW desservant les deux localités. Ces installations permettraient de réduire la consommation de mazout qui devrait passer de 300 000 litres à un million de litres entre la première et le trentième année d'exploitation. On a ensuite comparé la valeur du combustible économisé pendant 30 ans aux coûts prévus de production de l'énergie électrique. Il en ressort que la centrale hydro-électrique coûterait, en dollars actuels, plus de 7 millions de dollars de plus que les génératrices diesel.

On a ensuite élaboré diverses situations tenant compte de variations des hypothèses de base. Dans toutes les situations envisagées, compte tenu notamment d'une exploitation de 12 mois de la centrale, de variations du taux d'actualisation, du taux d'inflation, de la hausse du prix du combustible et de la capacité de la centrale, l'aménagement d'une centrale hydro-électrique n'était pas rentable. Même d'après les hypothèses les plus favorables, la centrale hydro-électrique coûterait environ 4 millions de dollars de plus que la production d'énergie au moyen de génératrices diesel.

L'aménagement hydro-électrique des chutes Vermilion en vue de fournir de l'énergie électrique aux localités de John D'Or Prairie et de Fox Lake est techniquement faisable, mais le projet n'éliminerait pas la nécessité de recourir à la production d'électricité par génératrice diesel et ne permettrait pas de réaliser des économies de carburant suffisantes pour être attrayant du point de vue économique.

On considère que les études complémentaires du potentiel de l'aménagement hydro-électrique proposé à l'emplacement des chutes Vermilion ne se justifient pas.

L'étude a été effectuée par Acres Consulting Services Ltd. pour l'Alberta Power Ltd. avec une contribution du Programme de démonstration dans les collectivités éloignées, d'Énergie, Mines et Ressources Canada.

1 - INTRODUCTION

The Vermilion Chutes on the Peace River consist of a series of rapids with a total fall of approximately 3 m located about one kilometer upstream from a distinct linear waterfall with a measured drop of 4.5 m. The names "Vermilion Rapids" and "Vermilion Falls" refer to the rapids and falls respectively.

The Vermilion Falls hydroelectric project would be located on the left bank of the Peace River at Vermilion Falls 130 km east of High Level, Alberta. The site is approximately midway between the communities of John D'Or Prairie and Fox Lake which would be serviced by the power plant. The site location is shown on Figures 1 and 2. The 4.5 m head and large river flows at the site offer an opportunity for generation of hydroelectric power by diverting a small part of the available flows through low head turbines.

This prefeasibility level study addressed the technical and economic aspects of the development. Possible environmental, socio-economic, land rights and regulatory issues were not considered. These multi-disciplinary aspects would be included as part of subsequent feasibility studies carried out to a greater level of detail. The study was carried out with the financial support of Energy, Mines and Resources, Canada (EMR) under the Remote Community Demonstration Program. The objective of this program is to demonstrate oil reduction or displacement techniques and measures which will improve the quality, price and security of energy supply in remote Canadian communities. A financial contribution to the cost of the study was also made by Alberta Tourism and Small Business (Northern Development Branch).

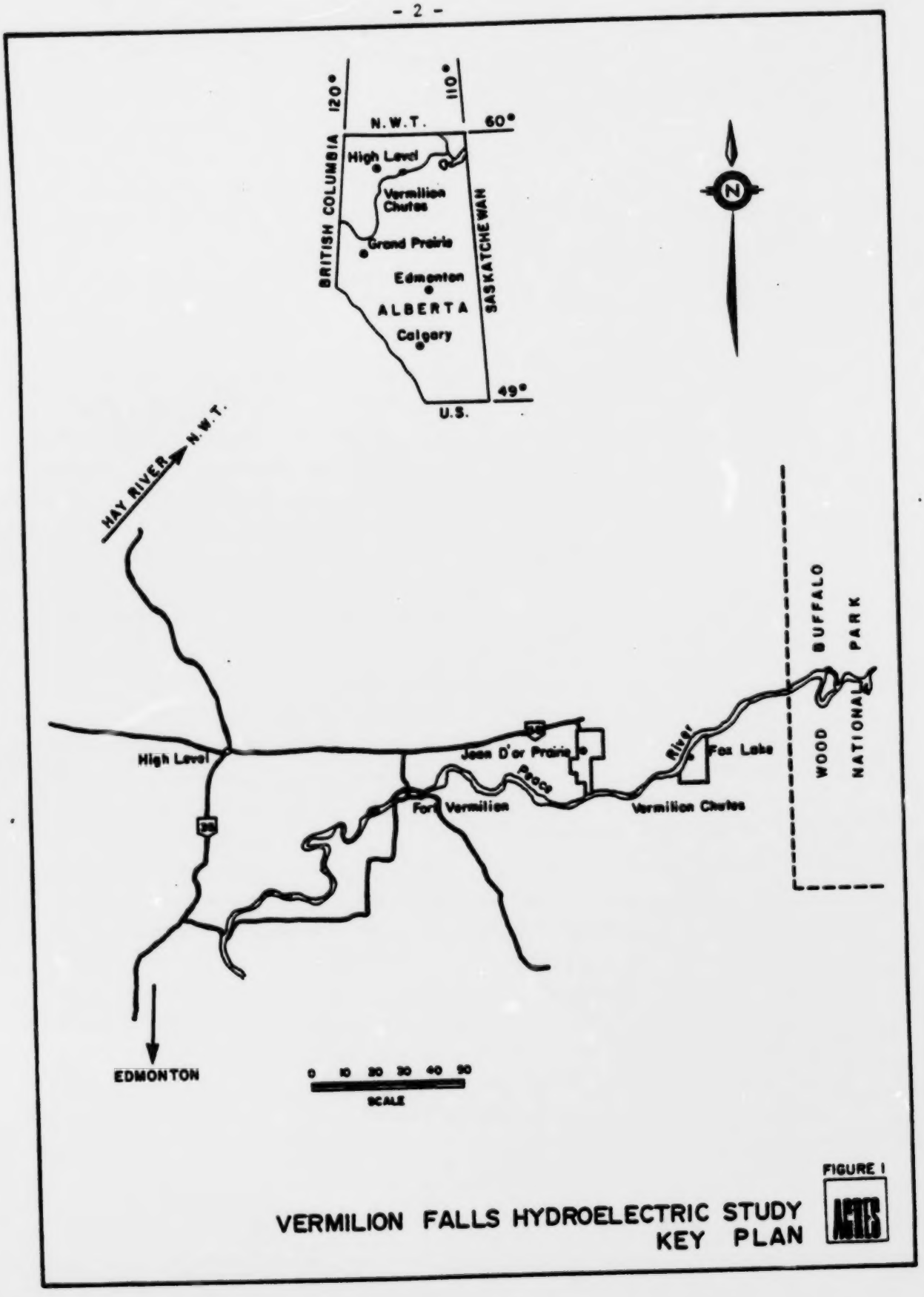


FIGURE 1

VERMILION FALLS HYDROELECTRIC STUDY
KEY PLAN

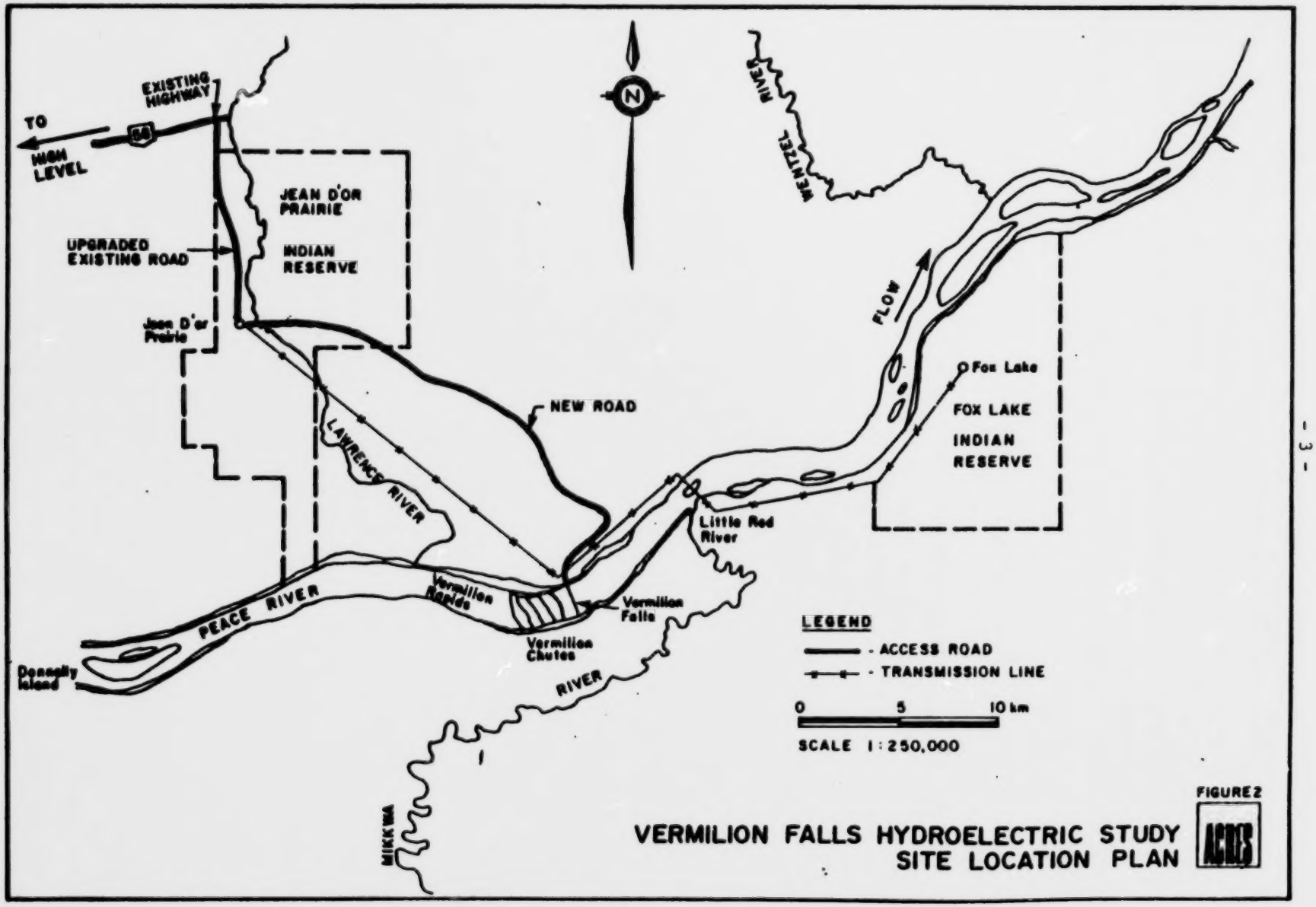


FIGURE 2

VERMILION FALLS HYDROELECTRIC STUDY
SITE LOCATION PLAN

ACRES

The study was prepared jointly by Alberta Power Limited (APL) and Acres Consulting Services Limited (ACRES). APL was responsible for the load forecasts, the transmission line design and costing, and the economic and financial analyses. ACRES was responsible for the engineering and construction aspects of the study and prepared preliminary designs and capital costs estimates.

The scope of work for the study, adopted in consultation with EMR, is included as Appendix A to this report. The study was authorized on July 26, 1984 and was carried out during the period August 1984 to March 1985.

2 - SITE CONDITIONS

The project site was inspected by three engineers from APL and ACRES on September 7, 1984. The party was accompanied by Mr. E. Kilotat of EMR, St. Albert, Alberta, office. A Hughes 500D helicopter transported the party from the High Level airport to the project site.

Studies of aerial photographs and National Topographic System mapping had indicated that attractive sites for development of small hydroelectric stations exist at the ends of Vermilion Falls on both river banks. A site near a ledge of rock at the left bank was selected for study. A similar rock ledge exists on the right bank but development on this side of the river would require considerably higher access costs. Sites at Vermilion Falls are much more attractive than any sites at the upstream Vermilion Rapids or any project which would develop the total head across both the rapids and falls.

It was possible to land the helicopter on a ledge of rock at the left river bank above Vermilion Falls and carry out reconnaissance surveys at the selected site.

Site Description

The proposed site of the hydroelectric development is a flat rock ledge which exists on the left bank of the river at the falls. At this location the river is actively eroding upstream at a faster rate than over most of the 1.6 km wide falls. A 60 m wide channel has been cut approximately 100 m upstream of the general line of the falls. Most of the available 4.5 m drop occurs within this channel. Adjacent to the channel there is a generally horizontal rock ledge located just above river level at its upstream end. The ledge protrudes into the river 80 m over a length of approximately 200 m. The river side of the ledge is being eroded and undercut. Large blocks of rock have broken off and have fallen into the river.

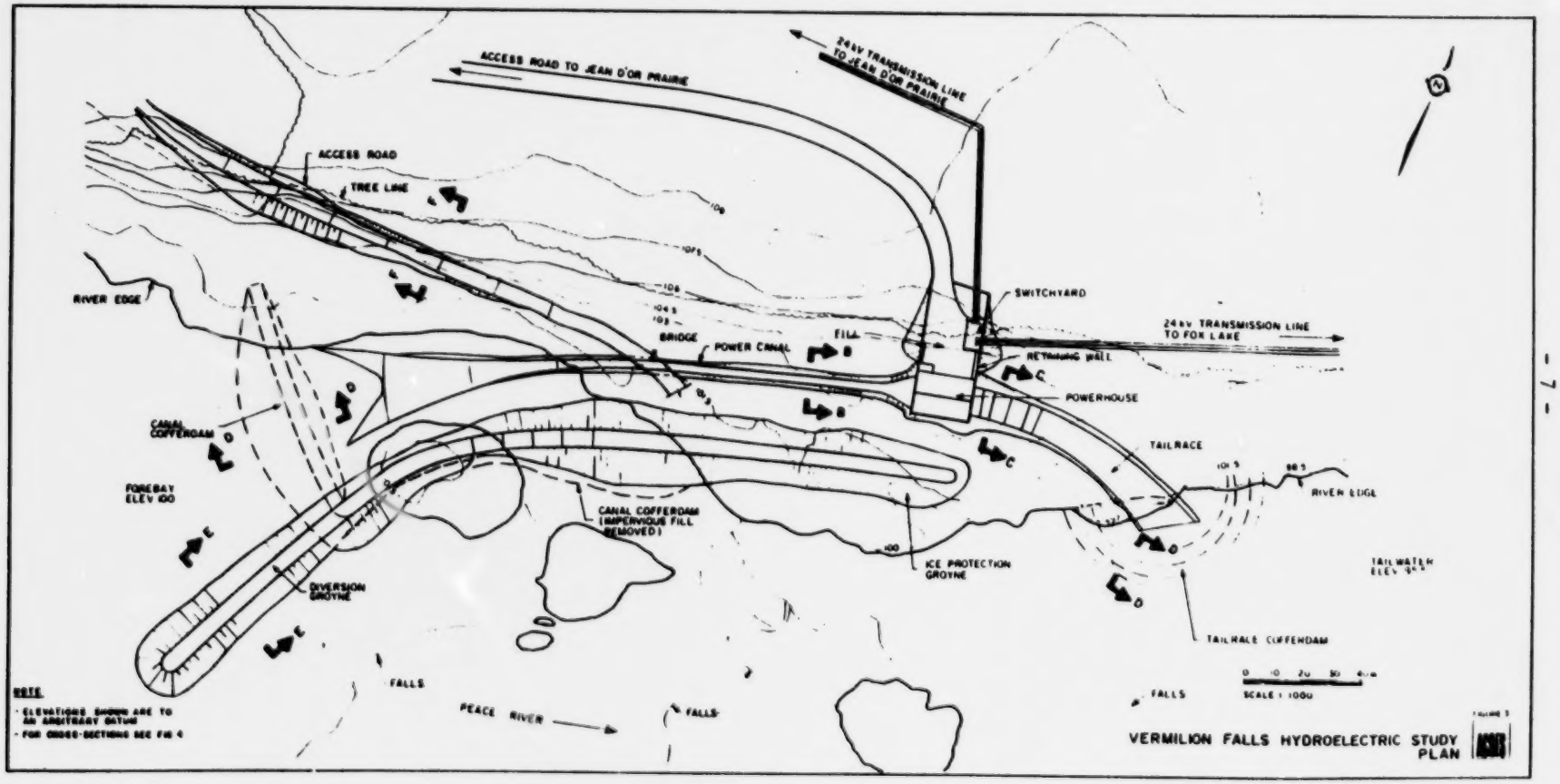
The surface of the rock slopes gently upwards towards the bank, where it steepens sharply and rises to the top of the river bank 8 m above the rock ledge. The steeper part of the slope is covered with a veneer of broken weathered rock and soil containing large quantities of gravel and cobbles and vegetated with sparse grasses and young willows. A dense stand of poplars is found at elevations 6 m above the rock ledge and higher. The demarcation line between the trees and the slope is abrupt and extends upstream and downstream for at least 1 km. This is interpreted as being the limit of ice scour, and leads to the conclusion that ice jamming downstream frequently causes the falls to be flooded during the winter.

There are three low lying rock islands about 40 m in diameter in the river upstream and adjacent to the ledge. These are less than 1 m above river level.

Topography

During the site inspection, a base line was set out and referenced to features identifiable on the aerial photographs. Elevations of the rock surface and the adjacent water surface were taken with a theodolite. In this manner, it was established that, at the time of the inspection, there was 4.5 m of head available from the relatively calm water upstream of the ledge to that downstream of the falls.

This surveyed profile of rock surface was used in conjunction with 1:15,000 scale aerial photographs to produce the topography which formed the base plan for the layout shown in Figure 3. The aerial photographs were obtained from Alberta Energy and Natural Resources, Edmonton. The topography was prepared by Burnett Resource Surveys Ltd., Calgary. The relatively calm river surface upstream of the falls provided the required vertical control together with the surveyed



VERMILION FALLS HYDROELECTRIC STUDY
PLAN

profile. Horizontal control was also obtained from the surveyed profile and by extrapolation from National Topographic System 1:50,000 scale map sheet 84J/7. The accuracy of the mapping is considered adequate for developing conceptual designs and preliminary cost estimates for this study. An arbitrary elevation datum of 100.0 m for the relatively calm water upstream of the rock ledge was selected resulting in a normal tailwater level at elevation 95.5 m.

An inconsistency between the inferred photogrammetric contours and the field measurements should be noted. The available head, determined by photogrammetrical methods while preparing the topographical mapping was measured to be 3.5 m. Spot elevations obtained by such methods have a nominal accuracy of one quarter of the 1.5 m contour interval or 0.4 m. This inconsistency was not reconciled but the 4.5 m head, established by levelling during the site inspection, was used in the study. The contours were nonetheless considered to be adequate for the purpose of the study.

The level of ice scour at the site was determined to be at approximately elevation 106 m, both by levelling during the site inspection and from the aerial mapping.

Geology

The rock exposed on the ledge and on the river bottom is the upper part of the 130 m thick succession of grey, green and reddish limestone and dolomitic limestone with minor shale layers, that is known as the Mikkwa Formation. The boundary between the Mikkwa Formation and the overlying Grosmont Formation, a reefal, coarsely vuggy, dolomite, occurs in the upper part of the river bank.(1) The rock observed on the surface of the ledge and exposed along the river's edge

(1) Bedrock Geology of Northern Alberta, Research Council of Alberta, 1969.

downstream of the falls is hard, competant, and horizontally bedded. The rock is open jointed close to the river. There is little evidence of major weathering but there is a tendency for differential weathering of the different layers. This is seen where the river has undercut the ledge and large blocks have broken away. It is considered that excavated slopes could be designed to be stable for the duration of the project. Minor rock bolting and wire meshing of the slopes would be required. The rock should break easily with little line drilling.

Construction Materials

A detailed search for construction materials was not considered appropriate to the level of detail required for this study. Discussions with engineers from Alberta Transportation revealed that coarse granular deposits exist along Highway 58 in suitable quantities and of a type that would be suitable for road surfacing and for the transition zone between the rock fill and impervious zone of the cofferdams. There is a commercial gravel pit at Fort Vermilion that could supply concrete aggregates. Other suitable deposits exist in the river bed but, for the purposes of the cost estimate, it has been assumed that processing and access road costs would make this source more expensive than the Fort Vermilion pit. Impervious material for the cofferdams would be readily available in the overburden on top of the river bank. Adequate road subgrade material would be found along the new access road route with the possible exception of the southern leg which passes through some swampy areas.

Seismicity

The project site is located within Seismic Zone 0 of the Seismic Zoning Map presented in the National Building Code of Canada. A seismic risk analysis for the site carried out by

the Earth Physics Branch, Energy, Mines and Resources Canada confirms that seismic forces can be expected to be very minor at this location. The results were as follows:

Probability of Exceeding (per year)	.01	.005	.002	.001
Peak Horizontal Acceleration (% g)	1.1	1.3	1.6	1.9
Peak Horizontal Velocity (m/s)	0.030	0.036	0.045	0.055

(g = acceleration due to gravity)

3 - HYDROLOGY

Ice Conditions

Data from direct on-the-ground observations of ice conditions at this site were not available for this study. Instead, these conditions and the effect on the proposed installation have been inferred from the annual/perennial vegetation demarcation at the site, from satellite imagery, and from ice regime behavior at similar sites.

During the site inspection, it was noted that there was a distinct demarcation on the banks between the tree growth and the growth of grasses, weeds and low shrubs. This line was approximately 6 m above the open water and extended upstream and downstream for at least 1 km. It appeared to be essentially horizontal with no discernable break in grade at the falls.

Microfiche copies of satellite imagery for this area were examined in the offices of the Alberta Remote Sensing Centre, Edmonton. Comments on the ice conditions for each photograph examined under the microfiche are tabulated in Table 3.1. The overall impressions of the ice conditions gained from this examination are:

- an ice cover forms in the river upstream and downstream of Vermilion Chutes in later October to early November
- during the winter the rapids are gradually closed by ice
- in some winters, all or part of the rapids may remain open, while in other winters, the rapids may completely close
- the river breaks up from mid April to early May with the rapids opening up first
- a large accumulation of ice downstream of the falls is the last to melt.

Selected photographs, having a much clearer resolution than the microfiche, were obtained from the Prince Albert Satellite Station. Enlarged copies of these are shown in Appendix B. Although the definition of the copies is poor compared to the original photographs, they do show the ice conditions at the time. A detailed examination of these photographs confirmed the above impressions. Also, it became apparent that during much of the winter months, the rock ledge upon which the proposed project would be located was covered with ice.

It is therefore believed that the Peace River at Vermilion Chutes behaves in a manner similar to other large northern rivers at rapids and falls. During the early winter, an ice cover readily forms in the low velocity areas upstream and downstream of the falls and rapids. Throughout the reach of the rapids, velocities are too high to allow an ice cover to form. In this reach, the water approaches supercooling with the resulting formation of slush ice, suspended in the flow. This slush ice is transported under the downstream ice cover. Where the velocity is sufficiently low, the slush ice is deposited against the underside of the ice cover. As more and more ice is deposited in this hanging dam, the flow area under the ice becomes more and more restricted. This causes an increase in the hydraulic gradient with a corresponding rise in ice and water level. As the process continues, the rising water level causes the rapids to be flooded.

From the above evidence, it is believed that this process effectively eliminates the head across Vermilion Falls from about the beginning of December to the end of March. Responses to a questionnaire circulated in the project area (Appendix B) corroborate this opinion. Confirmation of this would require field surveys of the actual ice processes at the site. It is not considered that a project developed in the Vermilion Rapids would have a significantly better availability.

TABLE 3.1

LANDSAT MICROFICHE
ICE CONDITIONS SHOWN ON LANDSAT IMAGERY

Landsat #1 - Track 49 Row 19

Date	
19/04/74	Ice in river upstream and downstream with the rapids apparently open
15/10/77	River open
14/05/76	River open
*03/03/76	River closed including rapids
16/11/75	River closed upstream and downstream with the rapids apparently open
29/10/75	River open obscured by clouds
*27/03/75	Ice in river upstream and downstream with rapids open
*09/03/75	Ice in river upstream and downstream with rapids open
19/02/75	Ice in river upstream and downstream with rapids, some obscuring clouds
*01/02/75	Ice in river upstream and downstream rapids apparently open

Landsat #2 - Track 49 Row 19

Date	
04/11/79	River upstream and downstream and the rapids all open with ice or snow in some channels
08/05/79	Ice in river upstream and downstream with the rapids all open
*02/04/79	Ice in river upstream and downstream with south half of rapids open
*15/03/79	Ice in river upstream and downstream with south half of rapids partially open
25/02/79	Ice in river upstream and downstream with south half of rapids partially open
09/11/78	Ice in parts of river downstream with other parts open, upstream reach open
25/04/78	River closed with rapids open
20/03/78	River closed with south half of rapids open
02/02/78	River closed including rapids with possible open leads
*12/02/78	River closed including rapids with possible open leads
27/10/77	River open
12/04/77	River closed, lead at rapids possibly open
07/03/77	River closed including rapids
19/11/76	River open with patches of ice downstream
*22/01/82	River and rapids closed with small opening in middle of rapids
22/03/81	River and rapids closed

TABLE 3.1 (Cont'd)

Landsat #3 - Track 49 Row 19

Date	
*23/04/80	River has many ice free areas with a great deal of ice below rapids
18/03/80	River closed (photo poor)
13/11/79	River open with few areas of ice on channel edge
16/02/79	River closed upstream and downstream, with rapids apparently open (image poor)
18/11/78	River closed upstream and downstream with rapids open

Landsat #3 - Track 45 Row 19

Date	
01/05/84	River open
15/04/84	Ice color different possibly indicating breakup. Lots of ice immediately downstream of rapids
*30/03/84	Ice in river upstream and downstream with rapids open
14/03/84	Ice in river upstream and downstream with rapids open
11/02/84	Ice in river upstream and downstream with rapids open
26/01/84	Ice in river upstream and downstream including rapids. Leads apparently present.
09/12/83	Ice in river upstream and downstream with rapids open
12/03/83	River and rapids ice covered - no leads
*23/01/83	River and rapids ice covered - no leads
06/12/82	River ice covered with rapids open (photo poor)
17/10/82	Open but some ice downstream at bends

Landsat #5 - Track 45 Row 19

Date	
13/04/84	River clear except immediately downstream of rapids
07/04/84	River closed with rapids open (photo poor)

* Copies of these photographs are included in Appendix B.

Water Supply

The hydrometric station on the Peace River nearest to the site was operated by the Water Survey of Canada at Fort Vermilion. The difference in drainage area between Fort Vermilion and Vermilion Chutes is quite small. The Fort Vermilion station was operated for only a limited number of years and winter records are available for only a few years. The station is now discontinued. The next closest stations having reasonable lengths of record are at Peace River and at Peace Point.

Since 1968, all stations on the Peace River have been effected by the regulation of Williston Reservoir in British Columbia. The outflow patterns from Williston Reservoir will depend on future power demands and on the future configuration of B.C. Hydro's system. As part of the Slave Hydro Feasibility Study, monthly flows from 1940 to 1980 were developed at Peace River and at Peace Point for four scenarios of B.C. Hydro's future operation. (Refer to Slave River Hydro Feasibility Study - Project Design - Appendix B - Hydrology - February 1982.) For the current study, it was assumed that the average of these four scenarios represented reasonable future flow patterns at these two stations. By prorating on a drainage area basis, flow data for Vermilion Chutes were inferred. These are shown in Table 3.2.

Flood Hydrology

As noted above, there are only limited hydrometric records at Fort Vermilion, the closest station to the site. Discharges at this station and at other stations along the Peace River are now influenced by the operation of Williston Reservoir. Hence, standard flood frequency analysis of recorded peak discharges cannot be used for flood design.

TABLE 3.2

AVERAGE MONTHLY FLOW RATES FOR THE PEACE RIVER AT FT. VERMILION - FLOW IN M^3/s

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1940										1614	1399	1119
1941	1352	1337	1470	1443	1611	2287	2746	1986	1649	1856	1474	1174
1942	1368	1283	1295	1326	1686	3572	3544	2403	2246	1916	1471	1292
1943	1452	1254	1143	2224	1914	3440	3126	2303	1684	1764	1493	1199
1944	1479	1299	1404	1679	2389	6117	3388	1731	1325	1485	1350	1020
1945	1353	989	1347	1484	1717	2873	2132	1784	1572	1939	1426	1314
1946	1414	1258	1375	1761	2953	2936	1798	1210	1170	1764	1315	945
1947	1090	1231	1104	1662	2456	3114	1955	1714	1517	1586	1371	1029
1948	1167	1670	1555	2186	6636	3512	1549	1792	1326	1955	1422	1181
1949	1414	1493	1461	1766	2804	3601	2968	2479	1779	1848	1366	1261
1950	1224	1420	1262	1761	2491	2716	1903	1570	1205	1410	1074	839
1951	1195	1576	1392	1596	3362	3525	2691	1681	1455	1874	1519	1220
1952	1514	1331	1285	1415	2164	2917	2355	1712	1473	1836	1147	1051
1953	1146	938	1406	1313	3624	3086	2456	2531	1753	1970	1404	1384
1954	1339	1676	1625	1858	3452	6519	4048	2689	3033	2175	1477	1753
1955	1415	1740	1696	2085	2513	4595	2811	2107	929	1261	1038	873
1956	1054	1456	1320	1684	2576	3164	1601	1341	1206	1691	1448	992
1957	1372	1774	1741	2197	3632	3372	2870	3743	1768	1923	1659	1337
1958	1318	1189	1070	2913	2928	3654	2046	902	972	1576	1564	1047
1959	1270	1749	1686	1799	2318	3531	2571	1326	1239	1546	1431	1089
1960	1254	1627	1665	1806	3308	5284	3430	1996	1527	1386	1309	1072
1961	1302	1574	1630	1853	2100	2905	2354	1031	1586	1568	1310	1098
1962	1320	1609	1668	2334	2797	2924	3628	2657	1806	1715	1517	1076
1963	1252	1523	1678	3514	4708	4055	2735	1799	1198	1516	1293	1006
1964	1184	1623	1599	2226	3489	6064	5334	5469	2649	1829	1416	1057
1965	1259	1608	1603	3133	3774	4424	4568	1500	1696	1955	1445	1118
1966	1210	1778	1696	3007	3835	3274	3228	2278	1799	1551	1522	1025
1967	1243	1671	1625	1905	5007	5494	2220	1388	1091	1513	1209	1091
1968	1493	1677	1752	2122	3165	4168	2358	1778	1199	1302	1277	908
1969	1219	1566	1665	1999	2957	2083	1581	1139	1560	1737	1436	1051
1970	1264	1308	1508	2186	2322	2663	1787	1167	1007	1068	1257	977
1971	1001	1063	1494	1887	2527	4359	3594	1136	1213	1799	1383	1028
1972	1019	1414	1721	2741	4677	6006	3324	2198	1707	1994	1420	800
1973	1187	1584	1608	3199	3917	3584	2407	1077	1043	1616	1231	898
1974	1014	1393	1781	3496	4887	3379	2392	1540	1236	1982	1204	1144
1975	1261	1031	1713	1678	2269	2551	2356	1248	1054	1147	1379	1202
1976	1125	1191	1379	2228	3155	3860	3728	4908	2283	2173	1974	1886
1977	1677	1202	902	2174	3617	3949	3243	2217	1599	2052	1963	2007
1978	1632	1886	1489	1699	2371	2846	1533	1184	1235	1368	1522	1978
1979	1721	1335	1158	2102	3147	4094	3149	1504	1522	1183	1500	966
1980	1294	1191	896	1015	1420	2812	1591		1923			

Flow sequence based on the Bennett Average Scenario of the Slave River Hydroelectric Study.

As part of the "Feasibility Study - Dunvegan Hydro Power Site", prepared by Alberta Environment, December 1976, the probable maximum flood on the Peace River at Dunvegan was estimated at 29 000 m^3/s. Of this 10 500 m^3/s represents the release from Williston Reservoir while the remainder is generated by downstream local runoff. Assuming that this downstream peak runoff is proportional to the square root of the drainage area, then the corresponding probable maximum flood at Vermilion Chutes would be 39 000 m^3/s.

Assuming critical flow at the brink of the falls, the water head above the brink predicted for this flood condition would be about 5.5 m. This flood level is approximately 1.5 m below the ice staging level, and therefore river staging during normal ice conditions, not the probable maximum flood level, would govern the design of this structure.

4 - POWER DEMAND

The forecast of electrical requirements for the area are identified by community:

Table 4.1: John D'Or Prairie Forecast

Table 4.2: Fox Lake Forecast

Table 4.3: Fox Lake and John D'Or Prairie Combined Forecast

Table 4.4: Monthly generation figures as a percentage of annual generation for John D'Or Prairie, Fox Lake, and the combined system

The source of this information is Alberta Power Limited.

TABLE 4.1

JOHN D'OR PRAIRIE
FORECAST OF ELECTRICAL ENERGY AND PEAK DEMAND

YEAR	PEAK (kW)	ENERGY (MW.h)
1985	215	850
1986	230	905
1987	245	960
1988	255	1015
1989	270	1070
1990	285	1125
1991	300	1180
1992	315	1240
1993	330	1295
1994	340	1345
1995	355	1405
1996	370	1460
1997	380	1515
1998	395	1570
1999	405	1625
2000	415	1685
2001	425	1740
2002	435	1795
2003	445	1850
2004	455	1905
2005	465	1965
2006	488	2063
2007	513	2166
2008	538	2275
2009	565	2388
2010	593	2509
2011	623	2633
2012	654	2765
2013	687	2903
2014	721	3048

TABLE 4.2

FOX LAKE
FORECAST OF ELECTRICAL ENERGY AND PEAK DEMAND

YEAR	PEAK (kW)	ENERGY (MW.h)
1985	215	825
1986	230	870
1987	240	910
1988	250	955
1989	260	995
1990	270	1040
1991	285	1060
1992	295	1125
1993	305	1165
1994	315	1210
1995	325	1250
1996	335	1295
1997	350	1340
1998	360	1385
1999	370	1430
2000	380	1475
2001	390	1525
2002	405	1570
2003	415	1615
2004	425	1665
2005	440	1710
2006	362	1796
2007	485	1885
2008	509	1979
2009	535	2079
2010	562	2182
2011	590	2292
2012	619	2406
2013	650	2527
2014	683	2653

TABLE 4.3

FOX LAKE AND JOHN D'OR PRAIRIE COMBINED
FORECAST OF ELECTRICAL ENERGY AND PEAK DEMAND

YEAR	PEAK (kW)	ENERGY (MW.h)
1985	387	1675
1986	414	1775
1987	437	1870
1988	455	1970
1989	477	2065
1990	500	2165
1991	527	2240
1992	549	2365
1993	572	2460
1994	590	2555
1995	612	2655
1996	635	2755
1997	657	2855
1998	680	2955
1999	698	3055
2000	716	3160
2001	734	3265
2002	756	3365
2003	774	3465
2004	792	3570
2005	815	3675
2006	856	3859
2007	899	4052
2008	943	4254
2009	991	4467
2010	1040	4690
2011	1092	4923
2012	1147	5171
2013	1204	5430
2014	1264	5701

Combined peak calculated using 90% of individual peaks to account for peak load diversity.

TABLE 4.4

MONTHLY GENERATION AS A PERCENTAGE OF ANNUAL FORECAST FOR JOHN D'OR PRAIRIE AND FOX LAKE

The following are monthly generation figures for John D'Or Prairie and Fox lake, expressed as a percentage of the total annual generation.

Month	John D'Or (%)	Fox Lake (%)	Combined (%)
Jan	13.9	13.0	13.5
Feb	8.8	10.8	9.8
Mar	10.7	10.1	10.4
Apr	7.4	8.5	7.9
May	5.7	4.9	5.3
Jun	8.1	5.3	6.7
Jul	4.6	8.1	6.3
Aug	8.4	8.0	8.2
Sep	5.4	6.9	6.1
Oct	6.8	7.6	7.2
Nov	9.9	8.3	9.1
Dec	10.3	8.5	9.5
	100.0	100.0	100.0

Note: The summation of generation for the months April through November inclusive totals 56.8%

5 - ALTERNATIVE DEVELOPMENTS

The study scope of work required two installed capacities to be considered. These were 500 kW and 1000 kW. Four options were identified:

- A 500 kW powerplant located on the north side of the river servicing the community of John D'Or Prairie only.
- A 500 kW powerplant located on the south side of the river servicing the community of Fox Lake only.
- A 500 kW powerplant located on the north side of the river servicing both communities.
- A 1000 kW powerplant on the north side of the river serving both communities.

The fourth option was selected for this study mainly because of the relatively high cost of constructing an access road to Vermilion Falls. An access road to the north bank site would cost in the order of 20 percent of the total capital cost of the 1000 kW project. An access road to a power plant sited on the south bank of the river would cost more than three times as much as an access road to a north bank site. This would make the second option considerably less economic. The economic evaluation considered the choice of a 500 kW capacity providing power to John D'Or Priarie or to both communities.

The access road, cofferdams and diversion groynes costs would be common to both a 500 kW and a 1000 kW installation. Similarly, most of the indirect construction costs would be effectively identical. The only savings in cost would be in the reduced rock excavation and in the transmission line to Fox Lake. The study therefore concentrated on the more economically attractive alternative with the larger installation supplying power to both communities. A less detailed cost estimate was prepared for the 500 kW project for comparison purposes.

6 - PROPOSED DEVELOPMENT

The development would divert a portion of the Peace River flow through a 500 kW or 1000 kW powerplant on the left and northern bank of the river at Vermilion Falls. A total head of approximately 4.5 m would be available. As the river flow is many times greater than the turbine flow throughout the year, the powerplant would be capable of meeting the power demand at all times, provided that the head is available. There would, however, be a period of some months each winter when the river ice jamming downstream of the falls would cause a significant loss of head and loss of power output. Under heads of less than 2 m, the Kaplan turbines would not operate efficiently and it would be necessary to shut the plant down to avoid excessive vibrations.

The project would be located on the ledge of rock on the left bank at Vermilion Falls as shown on Figure 3. The surface of the rock is generally above river level and provides an excellent opportunity for development. There are three low rock islands on the upstream side of the ledge. The northern most island could be used as part of the diversion works. A diversion groyne of dumped rockfill would be located between the ledge and the island and extended upstream as shown on Figure 3. The diverted flow would then be transported through a 290 m long canal to the powerhouse. After passing through the turbines, the flow would be returned to the river, downstream of the falls, through a tailrace channel excavated in the rock.

Permanent access would be provided to the powerhouse and also to the rock ledge. Surplus rock recovered from the excavation and from the cofferdams built for construction, would be placed as shown on Figure 3 to form a protective groyne to shelter the powerhouse from the force of impacting ice floes.

Transmission lines would carry power to both communities of John D'Or Prairie and Fox Lake. The latter line would require a major crossing of the Peace River. The existing diesel generator plant at both communities would be retained to provide power during the winter months when the falls are flooded by ice jams. The component structures of the development are described in detail in the following paragraphs.

Access

Access to the project site for construction, as well as for operations and maintenance, would be from provincial Highway 58, south to the community of John D'Or Prairie along a 10 km existing road and thence on a new 27.5 km gravel surfaced road to Vermilion Falls. The existing road to John D'Or Prairie would be upgraded to carry construction traffic. The new road would generally follow an existing trail along most of its length. Approximately fifteen percent of the new road would cross muskeg and swampy terrain. Road construction materials are available close to the northern part of the road. A longer haul would be required for granular road topping.

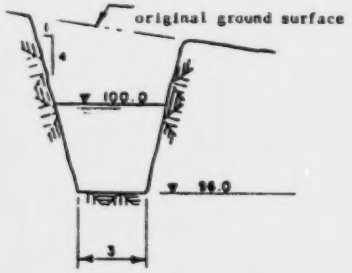
The access road represents a significant portion of the project cost. However, a permanent gravelled access road is deemed essential to the project, since any alternative involving winter roads, four wheel drive access during the summer, or river transportation is considered too unreliable even for a power project with full time generation back up.

At the project site the road would divide. One leg would follow high ground to the powerhouse. The other would provide access to the rock ledge as shown on Figure 3. A small concrete bridge would be constructed across the power canal for construction, for power plant operation and maintenance, and for repairing ice damage to the rockfill groynes.

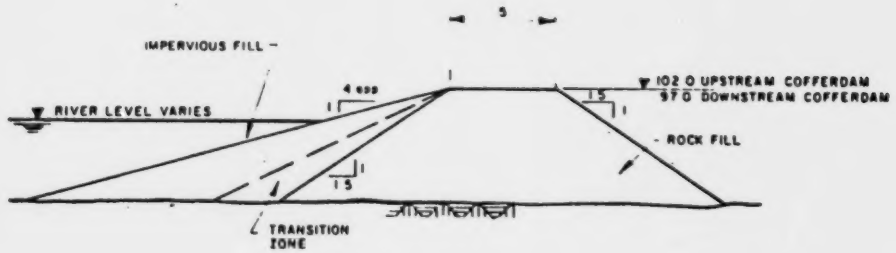
Cofferdams and Rockfill Groynes

Cofferdams, to permit excavation of the canal approach channel and tailrace channel, would be constructed of broken rock, from the required excavations, by end dumping in the river. At its upstream end, the cofferdam would cross from the rock ledge to a low rock island as shown on Figure 3. Part of the permanent diversion groyne would be placed at this time. A temporary cofferdam, shown in broken lines on Figure 3, would connect it to the upstream end of the rock ledge. The cofferdam would be sealed by dumping progressively finer soil on its upstream face. The sealing material would be obtained from river terrace deposits available close to the site. The excavation would be dewatered by pumping. After the canal excavation has been completed, the temporary portion of the cofferdam would be removed. The recovered material would be dumped into the river to extend the diversion groyne upstream as shown on Figure 3. It is anticipated that much of the finer grained sealing material would be lost during the process and any deficit would be made up with broken rock spoil from the required excavations. Although the groynes would not need to be watertight, the upstream seal of the groynes that were used as cofferdams would be left in place. These would be eroded away in time by the river and by ice.

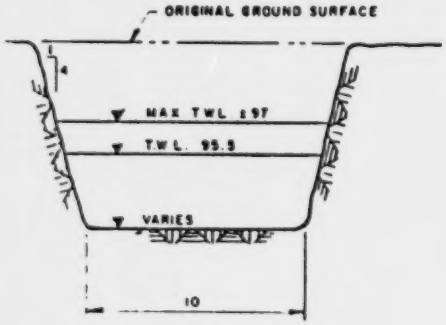
A temporary cofferdam would also be needed to complete the tailrace excavation. This would be constructed and removed in the same manner as described for the upstream cofferdam. The recovered material, though, would be used to construct, in part, the protective groyne upstream of the powerhouse. The remainder of this groyne would be built of rock spoil from the required excavations. This groyne would be a barrier to protect the powerhouse from the damaging effect of floating ice crushing against the concrete structure. Behind the groyne, the ice would be relatively static. The powerhouse walls would be designed to resist the static ice loads.



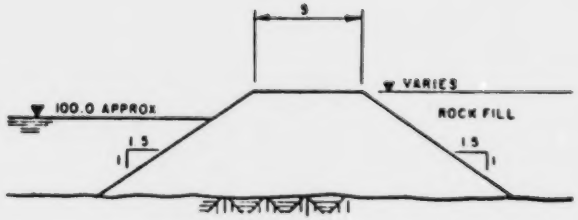
SECTION B-B
POWER CANAL



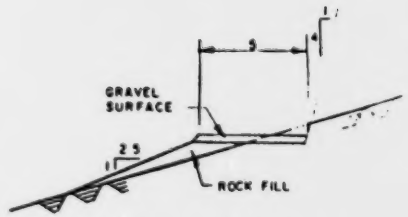
SECTION D-D
COFFERDAM



SECTION C-C
TAILRACE CHANNEL



SECTION E-E
ROCK FILL GROYNE



SECTION F-F
ACCESS ROAD

Figure 4
Vermilion Falls Hydroelectric Study Sections

During this study some effort was made to demonstrate that a balance is possible between the excavated rock and that required to construct the rockfill groyne, the access road and the fill behind to the powerhouse. This can be done by moving the layout of the canal, powerhouse and tailrace towards the river to reduce the volume of excavation, and by arranging the layout of the groynes for maximum effectiveness. There is a limit, however, beyond which the powerhouse would not be protected by the groyne from ice floe impact. This would result in an excess of excavated spoil. The layout on Figure 3 represents an approximate balance of materials. Because of the lack of site data, particularly on the surface of the river bed, an allowance for possible imbalance was made to the quantities used for the cost estimate.

The cofferdams and groynes would have cross sections as shown on Figure 4. The slopes shown for rock and soil that would be dumped in water are those used for estimating purposes. The actual slopes would depend both on the velocity of the river at that point and on how the material is dumped.

Power Canal

The power canal would follow the line shown on Figure 3. The section on Figure 4 indicates the excavated slopes assumed for estimating purposes. A flatter excavated slope would be necessary where soil overburden was encountered at the top of the river bank near the powerhouse and on the access road. At the entrance to the canal, the excavation would be wide and the canal invert would slowly drop to elevation 96 m over the first 100 m. From that point to the powerhouse, the invert would be 3 m wide and would continue at elevation 96 m. At the powerhouse intake, the canal would be gradually widened to accommodate the intake spacing. A head pond elevation of 100 m has been assumed for the study.

Landsat imagery indicates that there is substantial open water just upstream of the falls during the freeze up period before the falls are flooded out. As a consequence, the river water would be supercooled and would contain frazil ice which would flow into the canal. As the intakes and powerplant must be designed to pass frazil ice, a canal velocity as high as 2.5 m/s could be used which would minimize excavation quantities. Although a lower velocity would allow an ice cover to form, it would only reduce the amount of frazil ice passing through the powerplant by a negligible amount.

A permanent skew bridge of concrete supported on concrete piers built into the excavated walls of the canal would allow access to the rock ledge for construction maintenance and repairs to the rockfill groynes. This is shown in plan on Figure 3.

Type of Turbines

Propeller turbines are most suitable for development of mechanical power from low-head waterfalls. In order to be able to operate the unit under part-load conditions an adjustable pitch (Kaplan) propeller turbine has been selected. The size and cost of the generator would be minimized by employing a gearbox speed increaser which would establish a much higher speed of rotation for the generator than that provided by the turbine.

Research has been carried out in recent years into means of exploiting the free stream flow energy of rapidly flowing rivers and tidal streams. Equipment analogous to wind turbines is being developed with the intent of finding a way of producing an economical low output supply of renewable energy. One such device, a darrieus-type rotor suspended vertically in the flow, has been called a "Vertical Axis Water Turbine". This type of turbine would not provide a practical basis for electricity production at Vermilion Chutes.

Prototype trials with a 2.4 m diameter by 1.5 m high rotor(1) yielded a maximum gross output of 5.2 kW and revealed that large scale installations would face extremely difficult deployment and mooring problems. Even the modest 500 kw loads of Fox Lake and John D'Or Prairie are well beyond the capability of such equipment.

Powerhouse

A section and plan of the powerhouse is shown on Figure 5. It would be a concrete structure with intakes at an invert elevation 96 m and draft tube inverts at elevation 91.5 m. The rectangular bellmouth intakes, 2.6 m wide by 3.4 m high, would transition to the 2.5 m diameter control valve. Slots would be provided to accommodate the movement of 2.8 m wide by 3.2 m high vertical lift roller gates that would be used to close off the water passages when necessary to repair and maintain the control valve. The gate guides and trashracks would be electrically heated. There would also be slots for 3.2 m wide by 2.9 m high vertical lift roller gates for downstream dewatering. One set of intake and draft tube gates would be provided. They would be raised and lowered by the travelling powerhouse crane.

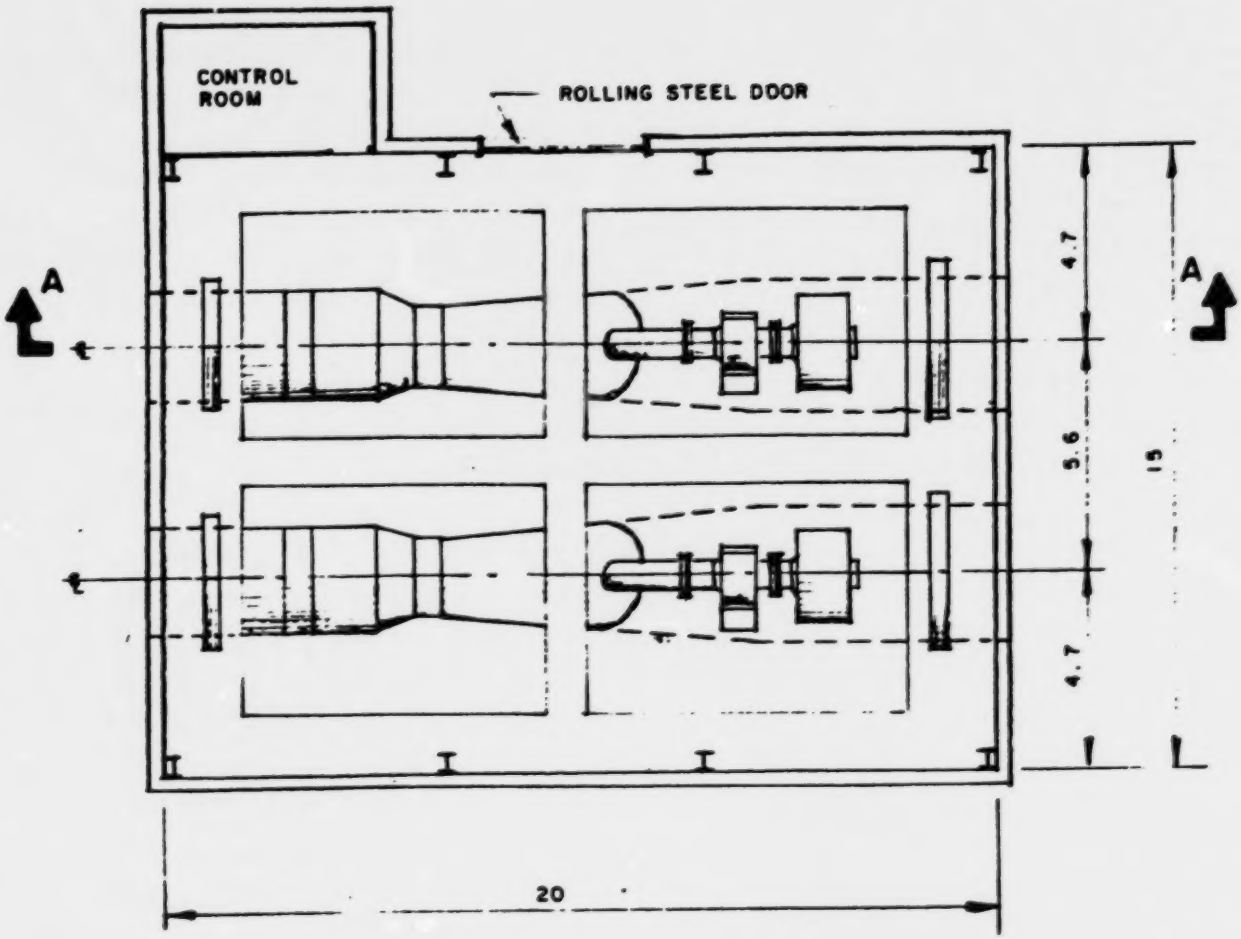
It has been assumed for the purposes of this study that, during the winter when the falls are flooded out, the river level could rise to elevation 107 m. The powerhouse

(1) National Research Council Technical Report TR-HY-005 NRC 23192, March, 1984.

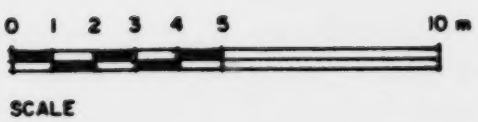
substructure would need to be constructed to above this high water level and would be of massive concrete construction to resist water pressures and the effect of buoyancy. Ice loading at all elevations above rock surface would be possible. The conceptual design shown in Figure 5 envisages reinforced concrete walls between elevations 102 m and 109 m, which would act as struts between opposite exterior walls. Below rock surface level, a clear space across the powerhouse for repairs and maintenance would be thus provided. At elevation 108 m, the upstream half of the floor would be grating to allow for ventilation. The downstream checker plate surface would act as the repair bay.

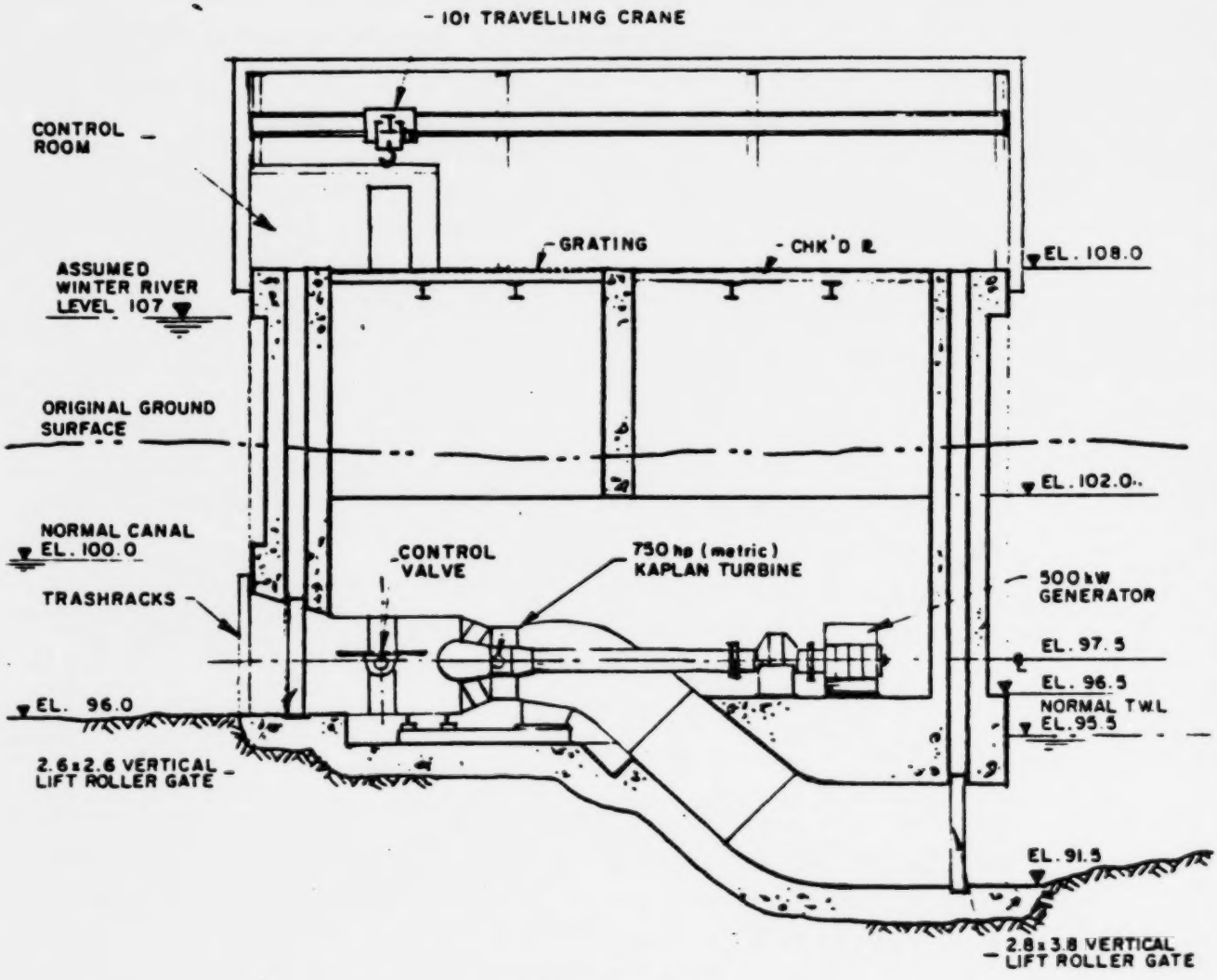
The powerhouse above ground surface would be an insulated, metal clad building supported between rigid steel frames with a clear span of approximately 14.5 m. A 10 t travelling crane would also be mounted on the building frame. A 5 m by 3 m annex would be used to house the control cabinets and equipment allowing the turbine floor area to be kept to a minimum. The powerhouse door would lead onto a fill area at elevation 108 m contained within two retaining walls between the powerhouse and the excavated slope. The switch yard would be located in this area as shown on Figure 3.

During detailed design, consideration could be given to reducing the quantity of concrete in the powerhouse. For example the exterior walls could be tapered towards the top. Also, a void, possibly gravel filled, could be left beneath the generator floor, and the base slab could be thinner. Care would have to be taken to ensure that there was sufficient weight to provide a safety factor against flotation and that the structure could resist all water and ice loads without developing cracks through which water could leak. Consideration could also be given to the use of rock anchors, possibly prestressed, or rock dowels to provide the required safety factors.



PLAN AT EL. 108.0





SECTION A-A

FIGURE 5

VERMILION FALLS HYDROELECTRIC STUDY
POWERHOUSE

The structure shown on Figure 5 is a conservatively realistic design that forms a good basis for costing. Cost savings alluded to above would be marginal considering the knowledge of the site and the project in general at this time.

Two 750 metric horsepower Kaplan turbines with fully adjustable blades and wicket gates, and rated at 4.5 m operating head with a throat diameter of 1800 mm would be provided. Each turbine would discharge 15 m^3/s at full output under the rated head. The generators would be rated at 500 kW each. The turbine would drive a high speed generator through a speed increaser or gear box. The inlet section and butterfly control valve chamber would be made of steel plate and would be flanged for connection to the valve. The runner chamber would be fabricated of stainless steel flanged to permit access to the blades. A fabricated flanged steel draft tube would be provided and would be encased in concrete to the turbine floor level at elevation 96.5 m. The axis of the turbine would be at elevation 97.5 m.

Tailrace

A 10 m wide tailrace channel excavated in the rock would return the water to the river downstream of the falls. The invert would slope up at six horizontal to one vertical from elevation 91.5 m to elevation 94.5 m.

Transmission Lines

A 24 km single pole 3 x 4 ACSR transmission line would be constructed for the powerplant to the community of John D'Or Prairie. To service the community of Fox Lake a similar transmission line would cross the Peace River using an island near Little Red River to minimize span lengths. This latter line would be 18 km long from the crossing to Fox Lake. The location of the transmission lines is shown on Figure 2.

7 - CAPITAL COST ESTIMATE AND SCHEDULE

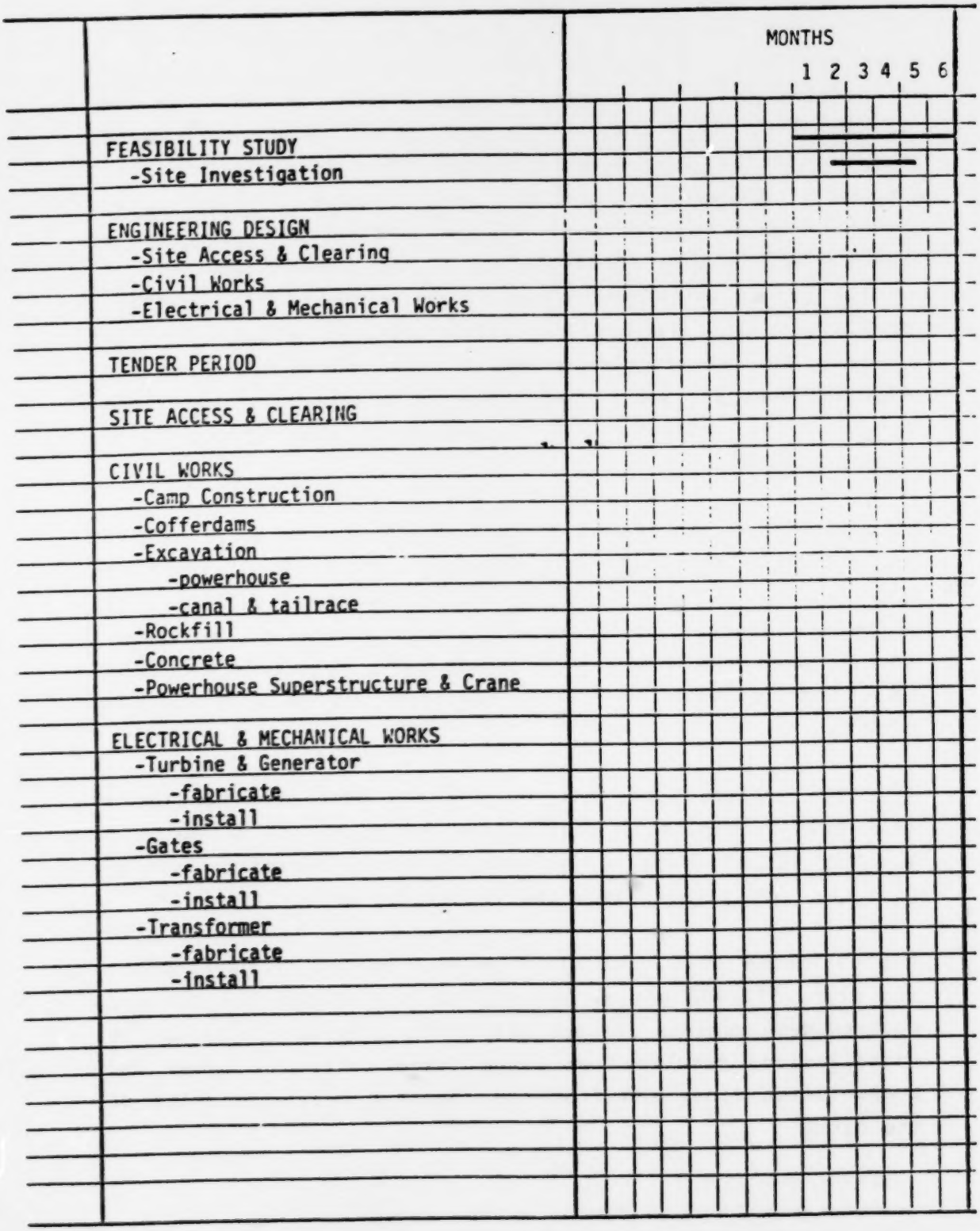
The capital cost estimates for the 1000 kW powerplant serving both communities and the 500 kW powerplant serving John D'Or Prairie only are presented in Tables 7.1 and 7.2 respectively. The estimates are based on unit prices developed for this study. The unit prices take into account the quantities of construction materials involved and unit prices tendered of similar scale projects constructed recently in western Canada. Both quantities and unit prices are subject to some error because of uncertainty and lack of detail on the site conditions. The estimate is, however, consistent with the prefeasibility level of detail of this study. The construction schedule shown on Figure 6 and an evaluation of the labor, materials and construction materials required to execute the work were also taken into consideration.

Contingency allowances of 20 percent for civil works and 15 percent for electrical works and for transmission lines have been used. These contingency allowances reflect the different degrees of uncertainty and extent of available knowledge at the time of the study. No allowance has been made for interest on funds required during construction (AFUDC).

The cost estimate does not include the cost of preparing a full multidisciplinary feasibility study of the project or the cost of preparing for and obtaining the necessary leases, licences, and permits from the regulatory authorities.

The estimated unit costs for the two scales of development are high, $11,908 per kW and $8,692 per kW for the 500 and 1000 kW developments respectively. The high unit cost of the installations results from large fixed costs for roads and transmission lines and from the inherent characteristics of the site.

VERMILION FALLS PROJECT IMPLE-



HYDROELECTRIC STUDY
MENTATION SCHEDULE

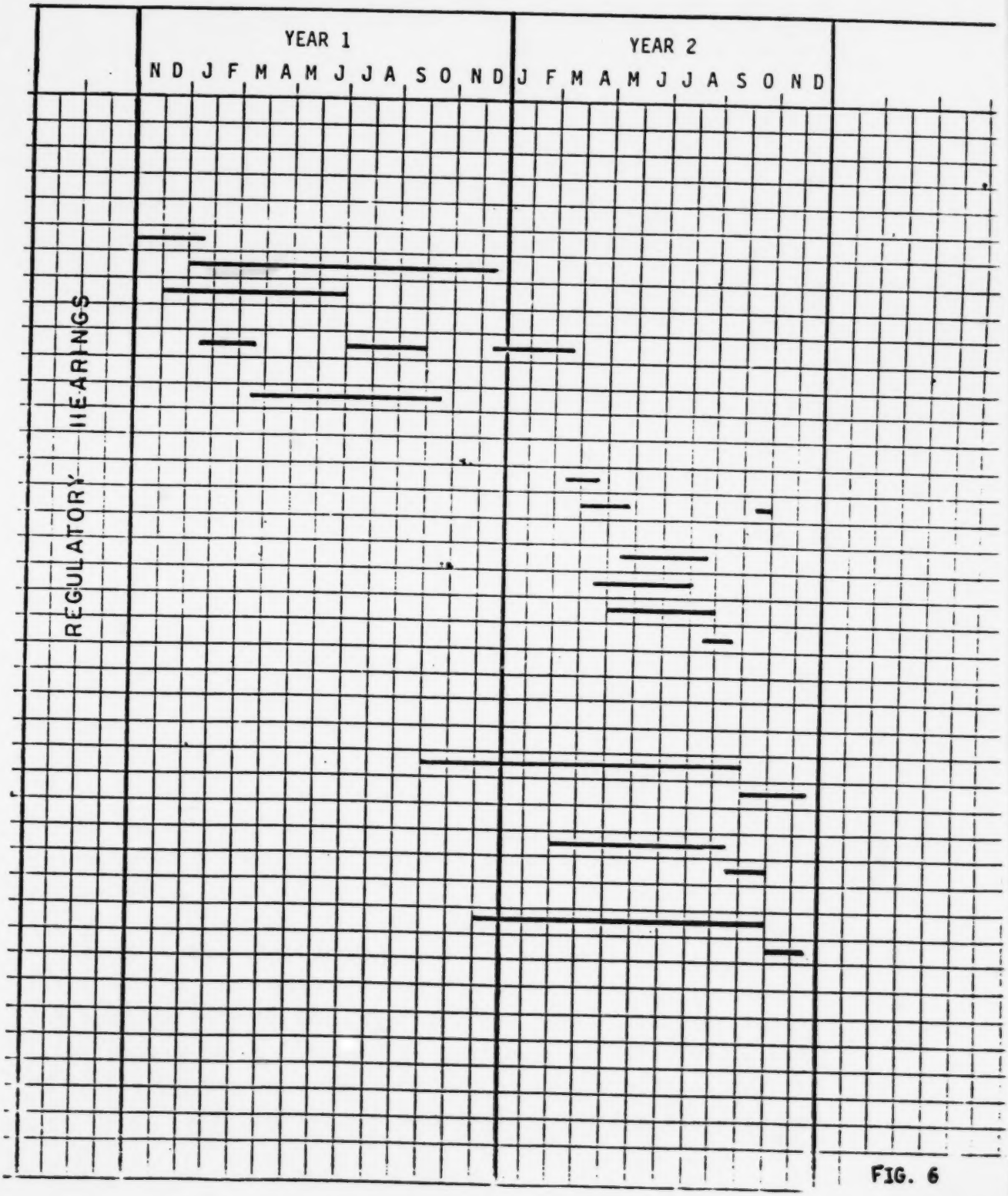


FIG. 6

The estimated unit costs for the two scales of development are high, $11,908 per kW and $8,692 per kW for the 500 and 1000 kW developments respectively. The high unit cost of the installations results from large fixed costs for roads and transmission lines and from the inherent characteristics of the site.

The Vermilion Falls site is conveniently arranged for development with very simple intake and tailrace channel works. The working head of 4.5 m, however, requires that very large flows of water be passed through the powerstation and consequently very large control gates and turbines are required.

Even a small capacity power installation will require a tall structure to be built at the brink of the falls. From the foot of the falls to the ice flood water level is 16 m. In this location, any structure will be exposed to very severe forces from river ice and must be strongly built.

Schedule

The project implementation schedule is presented on Figure 6. It shows a six month period to fully investigate the site and to prepare the feasibility study. This would be followed by an indeterminate period when regulatory proceedings would be followed. Following a decision to proceed with the construction of the project, a two month period would be required to prepare basic designs and tender documents for the access road to the site. Construction of this access road would occupy the first year of construction. During this year, final design of the project and tender documents for the works would be prepared. Construction of the civil works and installation and commissioning of the turbines and generators could be completed by the end of the second year. It is seen that access to the site has a pronounced effect on the schedule and the capital cost of the project.

TABLE 7.1

VERMILION FALLS HYDROELECTRIC DEVELOPMENT
CAPITAL COST ESTIMATE - 1000 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE AND FOX LAKE

	($000)	($000)
Civil Works		
Rock and Earthworks	997	
Powerhouse Structures	1481	
Contingency 20%	495	
Subtotal		2973
Mechanical and Electrical Works		
Turbine and Generator	1800	
Gates, Guides and Travelling Crane	145	
Transformer	25	
Contingency 15%	295	
Subtotal		2265
Transmission Lines	700	
Contingency 15%	105	
Subtotal		805
Permanent Access Road		1,200
Project Total		7,243
Engineering, Management Construction Supervision, Land Acquisition and Other Owner's Costs - 20%		1,449
Total Estimated Cost ($1984) (without AFUDC)		8,693

TABLE 7.2

VERMILION FALLS HYDROELECTRIC DEVELOPMENT
CAPITAL COST ESTIMATE - 500 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE ONLY

	($000)	($000)
Civil Works		
Rock and Earthworks	862	
Powerhouse Structures	965	
Contingency 20%	365	
Subtotal		2192
Mechanical and Electrical Works		
Turbine and Generator	900	
Gates, Guides and Travelling Crane	95	
Transformer	20	
Contingency 15%	152	
Subtotal		1167
Transmission Lines	350	
Contingency 15%	53	
Subtotal		403
Permanent Access Road		1200
Project Total		4962
Engineering, Management Construction Supervision, Land Acquisition and Other Owner's Costs - 20%		992
Total Estimated Cost ($1984) (without AFUDC)		5954

TABLE 7.3

VERMILION FALLS HYDROELECTRIC DEVELOPMENT
CAPITAL COST ESTIMATE - 500 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE AND FOX LAKE

	($000)	($000)
Civil Works		
Rock and Earthworks	862	
Powerhouse Structures	965	
Contingency 20%	365	
Subtotal		2192
Mechanical and Electrical Works		
Turbine and Generator	900	
Gates, Guides and Travelling Crane	95	
Transformer	20	
Contingency 15%	152	
Subtotal		1167
Transmission Lines	700	
Contingency 15%	105	
Subtotal		805
Permanent Access Road		1200
Project Total		5364
Engineering, Management Construction Supervision, Land Acquisition and Other Owner's Costs - 20%		992
Total Estimated Cost ($1984) (without AFUDC)		6356

8 - ECONOMIC ANALYSIS

8.1 Methodology and Assumptions

The benefits of developing hydroelectric generation on the Peace River at Vermilion Falls were assessed by comparing the future cost of service of generating the electrical requirements, with and without the hydro development.

For the basic economic evaluation, site conditions which would limit power production at Vermilion Falls to the months of April through November were recognized. This means that diesel generation would still supply approximately 43 percent of the total required generation. Three cases were analyzed:

1) a 1000 kW installation designed to supply both Fox Lake and John D'Or Prairie, and

2) a 500 kW installation designed to serve John D'Or Prairie only, and

3) a 500 kW installation designed to serve both Fox Lake and John D'Or Prairie.

To test the impact of no power generation from April through November, the evaluations were also carried out assuming generation for the full year.

8.1.1 Method of Analysis

The total cost of supplying electricity by the hydro and diesel combination was calculated and subtracted from the corresponding cost of continuing to meet all electricity through diesel generation. Costs were

calculated in terms of annual revenue requirements, known as "Cost of Service", for each development alternative. The cost of service in a given year was calculated as the sum of the costs of:

1. fuel,
2. depreciation,
3. operation and maintenance, and
4. return on undepreciated investment (initial capital cost minus accumulated depreciation).

For the purpose of this comparative analysis, operation and maintenance costs for the hydroelectric station were assumed to be equal to the savings in operation and maintenance costs corresponding to the diesel generation which would be displaced. No capital investment in new or replacement diesel generators was accounted for and no credit for possible redundancy of part of the existing diesel facilities was applied.

The net saving in each year was discounted to a present (1984) value, over a period of thirty years, employing a discount rate of 13 percent per year. A 50 year period was also evaluated for sensitivity.

The following additional assumptions governed the analysis:

1. Depreciation of capital investment on a straight-line basis over 30 years.
2. Rate of return on undepreciated investment, 13 percent per year.
3. Project assumed to be commissioned at the end of 1984. Present worthing of annual costs which are assumed to occur at year end, is to the end of 1984.

4. Hydroelectric investment costs includes the costs for transmission facilities.

1000 kW installation to serve both Fox Lake and John D'Or Prairie (includes $800,000 transmission and $1,200,000 for new access roads)	$ 8,690,000
500 kW installation to serve John D'Or Prairie only (includes $400,000 transmission and $1,200,000 for new access roads)	$ 6,000,000
500 kW installation to serve both Fox Lake and John D'Or Prairie (includes $800,000 transmission and $1,200,000 for new access roads)	$ 6,400,000

As the construction period for the hydroelectric development is short (8 months) it was decided to omit the allowance for funds used during construction (AFUDC) in this preliminary analysis.

5. General inflation is assumed at 5 percent per year.

Sensitivity to the escalation of fuel prices has been tested at 4%, 5%, and 6% for each case.

6. Operation and maintenance costs for the transmission lines are assumed to be $10,000 per year in 1984 and escalated at the same rate as inflation.

7. The base diesel fuel price in 1984 has been taken to be $0.31 per litre based on 1984 APL costs.

8. A fuel rate of 3.30 kW.h per litre of diesel fuel has been assumed based on APL experience.

9. Costs of right-of-way and land acquisition and special additional social or environmental impact mitigating measures have not been included.

10. Income taxes have not been included in the calculations. (Over 95% of income tax paid is refunded back to the customer.)

8.2 Results of Analyses

8.2.1 Fuel Displacement

The fuel oil which could be displaced, in thousands of litres, is as follows:

TABLE 8.1

	Minimum (Base Year)	Maximum (30th Year)	Cumulative (15 Year)	Cumulative (30 Year)
1000 kW Installed	288	956	6 094	16 910
500 kW Installed Single Community Service	146	563	3 194	9 289
500 kW Installed Two Community Service	288	786	6 011	15 375

8.2.2 Economic Evaluation

The results of the analyses are presented in Table 8.2.

The hydroelectric installation does not result in a net present worth savings in any of the cases analyzed. The present values which were computed ranged from a net cost of $7.3 million for the 1000 kW development with the low fuel cost assumption, to a net cost of $3.8 million for the 500 kW development serving both communities with high average fuel cost and full year operation assumption.

The sensitivity of the predicted benefits to variations in rate of return on invested capital, discount rate, and rate of inflation was checked. The effects of changes in these parameters are also shown in Table 8.2.

TABLE 8.2

VERMILION FALLS SMALL HYDRO STUDY
HYDRO COSTS VERSUS DIESEL COSTS 1984 TO 2014

NET PRESENT WORTH TO 1984 ($ MILLIONS)

Rate of Inflation (%)	Nominal Discount Rate (%)	Fuel Escalation Rate (%)	Full Year Operation	1000 kW Installation	500 kW Single Community Installation	500 kW Two Community Installation
5	13	6	No	-6.91	-5.05	-4.73
5	13	5	No	-7.13	-5.17	-4.93
5	13	4	No	-7.32	-5.28	-5.10
5	13	5	Yes	-5.87	-4.53	-3.80
5	9.2*	5	No	-6.06	-4.61	-3.98

Note: Negative values mean a net cost.

* This case reflects a real discount rate of 4.0%

APPENDIX A

STUDY SCOPE OF WORK

APPENDIX A

SCOPE OF THE STUDY

The scope of the study covering both APL and ACRES efforts, and agreed to by EMR, is as follows:

"The prefeasibility study will address the cost of developing generation at the lower falls of the Vermilion Chutes. The proposed scope of work is outlined in the following work program.

Task 1 — **Data Collection**

Assemble available data from federal and provincial government, institutions, company and private sources. Such data will include Peace River flow records from Water Survey of Canada gauging stations, National Topographic System mapping to 1:50,000 scale, aerial photography, and geological maps and reports.

Task 2 — **Hydrology**

Investigate the effects of high river flows and ice jams on water levels in this reach of the river. The minimum flow in the Peace River is an order of magnitude greater than the flow of water required for the size of power development which is contemplated. Thus uncertainties related to the availability of power are those of the available head rather than the flow of water. If it is concluded that the head available may diminish at times during the year, develop a seasonal duration curve of potential energy generation.

Task 3 — Electrical Demand and Installed Capacity

The study will be carried out on the basis of developing either 500 kW or 1,000 kW of electrical output. The value of the resulting generation in meeting present and projected demands for electricity will be assessed by Alberta Power Limited as part of the economic analysis which they will carry out.

Task 4 — Initial Conceptual Studies

Using the available data, prepare and cost parametrically, alternative structure designs and layouts on both sides of the river for economic comparisons. Plant operations during river freeze-up will be an important consideration. Include the effect of transmission line and transportation access on costs. Select the best prospects for site inspection. The level of detail required by this task can be satisfied with the National Topographic System mapping at 1:50,000 scale in combination with stereoscopic study of aerial photographs and limited surficial mapping. Consideration will be given to VAWT Technology. Consideration will be given to VAHT technology.

Task 5 — Site Reconnaissance

Inspect the most attractive development prospects and potential sources of construction materials from the air and on the ground,

- to verify the topographical and geological assumptions made for the layouts during Task 4,
- to confirm, modify or reject structure concepts, layouts and,
- to assess the construction methods, logistics and constraints.

Verify by simple survey techniques, including barometric levelling, significant topographical information such as head drop over rapids and river bank height. Explore subsurface conditions with hand tools. If possible select the most attractive development.

Task 6 — Design and Layout

Optimize the design and layout of one (or possibly two) project development(s) using, if necessary, larger scale mapping prepared especially for the study from the aerial photographs using Geodetic Survey of Canada ground control. Use innovative but conceptually simple designs that will give consideration to locally available materials, construction and permanent access to the site, transmission line length, and ice conditions in the river, and will minimize environmental impacts and maintenance and operating costs.

Task 7 — Cost Estimate

Develop a project implementation schedule and estimate to a pre-feasibility level, the capital cost of the selected project development (or developments), using statistical cost data from manufacturers and from previous experience with remote northern construction of small projects.

Task 8 — Report

Prepare a report of the study discussing the findings, providing specific input for the economic study and recommending the work program for the next phase of the study.

A draft report will be reviewed with Energy, Mines and Resources and Alberta Power Limited personnel.

APPENDIX B
SAMPLE REPRODUCTIONS OF
LANDSAT IMAGERY

Plate #	Image Date	Landsat Number	Track	Row	Comments
B-1	01/02/75	1	49	19	Ice in river upstream and downstream with rapids apparently open
B-2	09/03/75	1	49	19	Ice in river upstream and downstream with rapids open
B-3	27/03/75	1	49	19	Ice in river upstream and downstream with rapids open
B-4	03/03/76	1	49	19	River closed including rapids
B-5	12/02/78	2	49	19	River closed including rapids with possible open leads
B-6	15/03/79	2	49	19	Ice in river upstream and downstream with south half of rapids partially open
B-7	02/04/79	2	49	19	Ice in river upstream and downstream with south half of rapids open
B-8	22/01/82	2	49	19	River and rapids closed with small opening in middle of rapids
B-9	23/04/80	3	49	19	River has many ice free areas with a great deal of ice below rapids
B-10	23/01/83	3	49	19	River and rapids ice covered - no leads
B-11	30/03/84	3	49	19	Ice in river upstream and downstream with rapids open

LANDSAT IMAGERY
RIVER ICE CONDITIONS
FEBRUARY 1, 1975

0 5 km

PLATE B-1

ACRES

•••••••••••••• - VERMILION FALLS

LANDSAT IMAGERY
RIVER ICE CONDITIONS
MARCH 9 , 1975

0 5km

PLATE B-2

ACRES

..... - VERMILION FALLS

LANDSAT IMAGERY
RIVER ICE CONDITIONS
MARCH 27, 1975

0 5km

PLATE 8-3

ACRES

•••••••••••••• - VERMILION FALLS

LANDSAT IMAGERY
RIVER ICE CONDITIONS
MARCH 3 , 1976

0 5km

PLATE B-4

AGRES

•••••••••••• - VERMILION FALLS

LANDSAT IMAGERY
RIVER ICE CONDITIONS
FEBRUARY 12 , 1978

0 5km

PLATE B-5

ACRES

•••••••••••••• - VERMILION FALLS

LANDSAT IMAGERY
RIVER ICE CONDITIONS
MARCH 15, 1979

0 5km

PLATE B6

ACRES

•••••••••••••••• - VERMILION FALLS

LANDSAT IMAGERY
RIVER ICE CONDITIONS
APRIL 2, 1979

0 5km

PLATE B-7

ACRES

•••••••••••••• -VERMILION FALLS

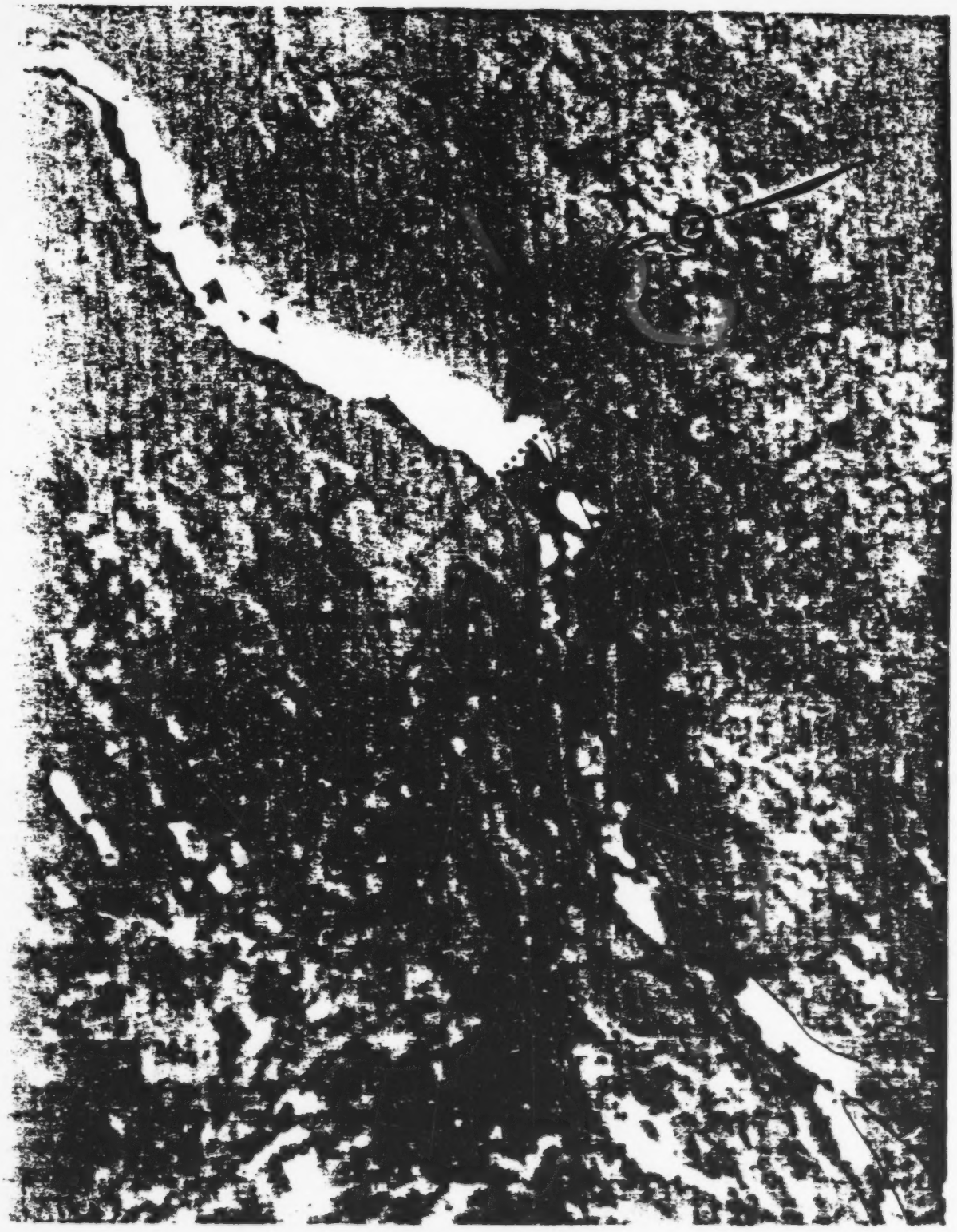
LANDSAT IMAGERY
RIVER ICE CONDITIONS
JANUARY 22, 1982

0 5km

PLATE B-8

ACRES

..... -VERMILION FALLS



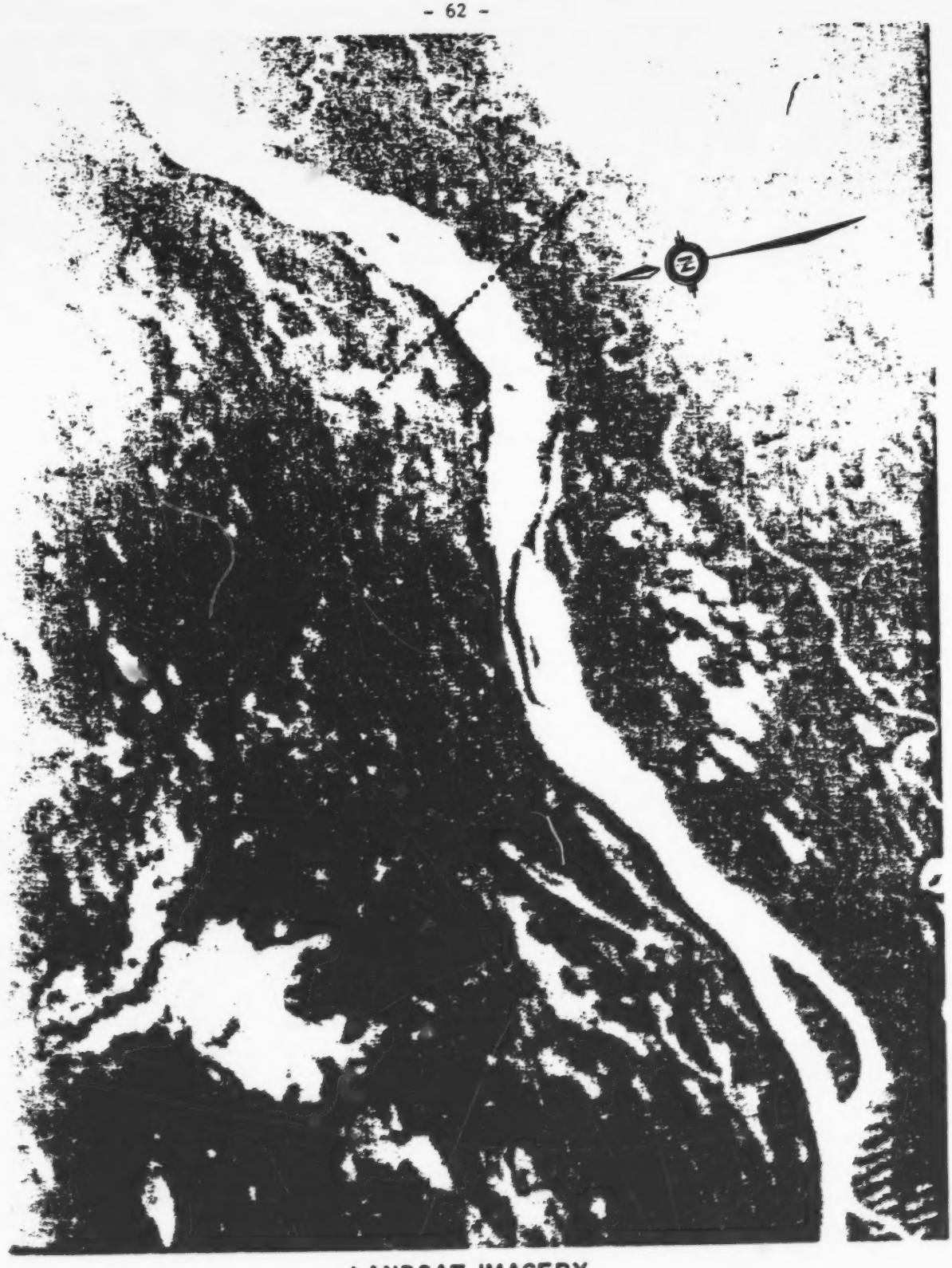
LANDSAT IMAGERY
RIVER ICE CONDITIONS
APRIL 23, 1980

0 5km

PLATE B-9

ACRES

•••••••••••• - VERMILION FALLS



LANDSAT IMAGERY
RIVER ICE CONDITIONS

JANUARY 23, 1983

0 5km

PLATE B10

ACRES

•••••••••••••••-VERMILION FALLS

LANDSAT IMAGERY
RIVER ICE CONDITIONS
MARCH 30, 1984

0 5 km

PLATE 8-11

•••••••••••••••• - VERMILION FALLS

ACRES

APPENDIX C

ECONOMIC ANALYSES

SUMMARY OF FUEL SAVED

VERMILION FALLS HYDRO STUDY
SUMMARY OF LITRES OF FUEL OIL DISPLACED

	1000 kW INSTALLATION TO SERVE BOTH FOX LAKE AND JOHN D'OR PRAIRIE				500 kW INSTALLATION TO SERVE BOTH FOX LAKE AND JOHN D'OR PRAIRIE				500 kW INSTALLATION TO SERVE JOHN D'OR PRAIRIE			
YEAR	TOTAL ENERGY (kW.h)	DIESEL ENERGY (kW.h)	FUEL OIL DISPLACED (LITRES)	CUMULATIVE FUEL OIL DISPLACED (LITRES)	TOTAL ENERGY (kW.h)	DIESEL ENERGY (kW.h)	FUEL OIL DISPLACED (LITRES)	CUMULATIVE FUEL OIL DISPLACED (LITRES)	TOTAL ENERGY (kW.h)	DIESEL ENERGY (kW.h)	FUEL OIL DISPLACED (LITRES)	CUMULATIVE FUEL OIL DISPLACED (LITRES)
1985	1675000	723884	288217	288217	1675000	723884	288217	288217	850000	367344	146259	146259
1986	1775000	767101	305424	593641	1775000	767101	305424	593641	905000	391114	155723	301982
1987	1870000	808157	321770	915411	1870000	808157	321770	915411	960000	414883	165187	467169
1988	1970000	851374	338977	1254389	1970000	851374	338977	1254389	1015000	438652	174651	641820
1989	2065000	892431	355324	1609713	2065000	892431	355324	1609713	1070000	462422	184115	825935
1990	2165000	935648	372531	1982244	2165000	935648	372531	1982244	1125000	486191	193578	1019513
1991	2240000	968060	385436	2367680	2240000	968060	385436	2367680	1180000	509960	203042	1222556
1992	2365000	1022081	406945	2774625	2365000	1022081	406945	2774625	1240000	535890	213367	1435922
1993	2460000	1063138	423292	3197917	2460000	1063138	423292	3197917	1295000	559660	222830	1658753
1994	2555000	1104194	439638	3637555	2555000	1105570	439221	3637138	1345000	581268	231434	1890186
1995	2655000	1147411	456845	4094400	2655000	1166119	451176	4088314	1405000	607198	241758	2131944
1996	2755000	1190628	474052	4568452	2755000	1227458	462892	4551206	1460000	630968	251222	2383166
1997	2855000	1233845	491259	5059712	2855000	1288452	474711	5025917	1515000	654737	260686	2643852
1998	2955000	1277062	508466	5568178	2955000	1349941	486382	5512299	1570000	678507	270150	2914002
1999	3055000	1320279	525673	6093851	3055000	1410694	498274	6010573	1625000	702276	279613	3193615
2000	3160000	1365656	543740	6637592	3160000	1475327	510507	6521080	1685000	728206	289938	3483553
2001	3265000	1411034	561808	7199399	3265000	1540959	522437	7043517	1740000	751975	299401	3782954
2002	3365000	1454251	579015	7778414	3365000	1604234	533565	7577082	1795000	775745	308865	4091819
2003	3465000	1497468	596222	8374636	3465000	1668059	544528	8121610	1850000	799514	318329	4410148
2004	3570000	1542846	614289	8988925	3570000	1735912	555784	8677394	1905000	823283	327793	4737941
2005	3675000	1588224	632356	9621281	3675000	1803432	567142	9244536	1965000	849214	338117	5076058
2006	3859000	1667743	664017	10285299	3859000	1921602	587090	9831626	2063000	891566	354980	5431038
2007	4052000	1751152	697227	10982525	4052000	2045499	608031	10439657	2166000	913137	379655	5810694
2008	4254000	1838450	731985	11714510	4254000	2175783	629763	11069419	2275000	912955	412741	6223434
2009	4467000	1930502	768636	12483146	4467000	2312117	652995	11722414	2388000	905803	449151	6672585
2010	4690000	2026876	807007	13290153	4690000	2455794	677032	12399446	2509000	907931	485173	7157757
2011	4923000	2127572	847099	14137253	4923000	2605204	702362	13101809	2633000	972654	503135	7660893
2012	5171000	2234750	889773	15027025	5171000	2764551	729227	13831036	2765000	1041580	522249	8183141
2013	5430000	2372828	926416	15953441	5430000	2931510	757118	14588154	2903000	1113437	542292	8725433
2014	5701000	2546958	955770	16909211	5701000	3105817	786419	15374573	3048000	1189252	563257	9288690

ECONOMIC ANALYSES

	Return/ Discount Rate	Inflation Rate	Fuel Escalation Rate	Page
1000 kW Installation Serving Both Communities				
- 30 Year Analysis	13	5	4	C-4
	13	5	5	C-5
	13	5	6	C-6
	9	5	5	C-7
- 12 month operation	13	5	5	C-8
- 50 Year Analysis	13	5	5	C-9

CAPITAL COST HYDRO ($)	8690000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	4%

VERMILION FALLS HYDRO STUDY
1000 kW INSTALLATION

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	BEGINNING YEAR RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT WORTH ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	8690000	289667	1129700	0	10500	723884	9.9	71451	1501318	1328600	387	1675000	165332	-1335986	-1182289
1986	8400333	289667	1092043	0	11025	767101	10.3	78746	1471481	2480985	414	1775000	182210	-1289270	-2191977
1987	8110667	289667	1054387	0	11576	808157	10.7	86279	1441908	3480300	437	1870000	199641	-1242267	-3052930
1988	7821000	289667	1016730	0	12155	851374	11.1	94528	1413080	4346969	455	1970000	218730	-1194350	-3785448
1989	7531333	289667	979073	0	12763	892431	11.5	103050	1384553	5098448	477	2065000	238448	-1146105	-4407508
1990	7241667	289667	941417	0	13401	935648	12.0	112362	1356846	5750167	500	2165000	259995	-1096851	-4934345
1991	6952000	289667	903760	0	14071	968060	12.5	120905	1328402	6314819	527	2240000	279762	-1048640	-5380081
1992	6662333	289667	866103	0	14775	1022081	13.0	132758	1303302	6805069	549	2365000	307189	-996113	-5754779
1993	6372667	289667	828447	0	15513	1063138	13.5	143614	1277241	7230243	572	2460000	332310	-944931	-6069332
1994	6083000	289667	790790	0	16289	1104194	14.0	155127	1251872	7599030	590	2555000	358948	-892924	-6332377
1995	5793333	289667	753133	0	17103	1147411	14.6	167646	1227549	7919049	612	2655000	387917	-839632	-6551267
1996	5503667	289667	715477	0	17959	1190628	15.2	180919	1204021	8196824	635	2755000	418629	-785392	-6732462
1997	5214000	289667	677820	0	18856	1233845	15.8	194985	1181328	8438009	657	2855000	451177	-730151	-6881533
1998	4924333	289667	640163	0	19799	1277062	16.4	209887	1159517	8647506	680	2955000	485660	-673857	-7003283
1999	4634667	289667	602507	0	20789	1320279	17.1	225670	1138632	8829563	698	3055000	522179	-616454	-7101848
2000	4345000	289667	564850	0	21829	1365656	17.8	242763	1119109	8987913	716	3160000	561731	-557378	-7180715
2001	4055333	289667	527193	0	22920	1411034	18.5	260863	1100643	9125733	734	3265000	603612	-497031	-7242952
2002	3765667	289667	489537	0	24066	1454251	19.2	279607	1082876	9245729	756	3365000	646983	-435893	-7291254
2003	3476000	289667	451880	0	25270	1497468	20.0	299432	1066249	9350290	774	3465000	692858	-373390	-7327871
2004	3186333	289667	414223	0	26533	1542846	20.8	320846	1051269	9441521	792	3570000	742408	-308861	-7354674
2005	2896667	289667	376567	0	27860	1588224	21.6	343494	1037587	9521206	815	3675000	794814	-242774	-7373319
2006	2607000	289667	338910	0	29253	1667743	22.5	375120	1032949	9591409	856	3859000	867993	-164957	-7384530
2007	2317333	289667	301253	0	30715	1751152	23.4	409636	1031272	9653434	899	4052000	947860	-83412	-7389547
2008	2027667	289667	263597	0	32251	1838450	24.3	447260	1032774	9708404	943	4254000	1034917	2143	-7389433
2009	1738000	289667	225940	0	33864	1930502	25.3	488440	1037911	9757292	991	4467000	1130205	92294	-7385085
2010	1448333	289667	188283	0	35557	2026876	26.3	533337	1046844	9800927	1040	4690000	1234092	187248	-7377280
2011	1158667	289667	150627	0	37335	2127572	27.4	582227	1059855	9840023	1092	4923000	1347218	287363	-7366680
2012	869000	289667	112970	0	39201	2234750	28.5	636019	1077857	9875208	1147	5171000	1471688	393831	-7353824
2013	579333	289667	75313	0	41161	2372828	29.6	702330	1108471	9907231	1204	5430000	1607217	498746	-7339416
2014	289667	289667	37657	0	43219	2546958	30.8	784025	1154567	9936747	1264	5701000	1754927	600359	-7324068

14-Mar-85

CAPITAL COST HYDRO ($) 8690000
LIFE (YEARS) 30
RETURN/DISCOUNT RATE 13%
INFLATION RATE 5%
FUEL ESCALATION RATE 5%

VERMILION FALLS HYDRO STUDY
1000 kW INSTALLATION

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	BEGINNING YEAR RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT WORTH ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	8690000	289667	1129700	0	10500	723884	10.0	72138	1502005	1329208	387	1675000	166921	-1335084	-1181490
1986	8400333	289667	1092043	0	11025	767101	10.5	80267	1473002	2482785	414	1775000	185731	-1287271	-2189612
1987	8110667	289667	1054387	0	11576	808157	11.0	88792	1444421	3483841	437	1870000	205455	-1238966	-3048278
1988	7821000	289667	1016730	0	12155	851374	11.5	98217	1416768	4352772	455	1970000	227264	-1189504	-3777823
1989	7531333	289667	979073	0	12763	892431	12.1	108101	1389604	5106993	477	2065000	250135	-1139469	-4396281
1990	7241667	289667	941417	0	13401	935648	12.7	119002	1363487	5761901	500	2165000	275360	-1088126	-4918928
1991	6952000	289667	903760	0	14071	968060	13.4	129281	1336779	6330113	527	2240000	299144	-1037634	-5359986
1992	6662333	289667	866103	0	14775	1022081	14.0	143320	1313865	6824336	549	2365000	331630	-982235	-5729463
1993	6372667	289667	828447	0	15513	1063138	14.7	156531	1290158	7253810	572	2460000	362198	-927959	-6038367
1994	6083000	289667	790790	0	16289	1104194	15.5	170705	1267451	7627186	590	2555000	394995	-872455	-6295382
1995	5793333	289667	753133	0	17103	1147411	16.2	186255	1246159	7952057	612	2655000	430978	-815181	-6507898
1996	5503667	289667	715477	0	17959	1190628	17.0	202934	1226036	8234911	635	2755000	469571	-756465	-6682419
1997	5214000	289667	677820	0	18856	1233845	17.9	220815	1207158	8481370	657	2855000	510946	-696213	-6824561
1998	4924333	289667	640163	0	19799	1277062	18.8	239977	1189606	8696304	680	2955000	555284	-634322	-6939168
1999	4634667	289667	602507	0	20789	1320279	19.7	260503	1173466	8883930	698	3055000	602780	-570686	-7030415
2000	4345000	289667	564850	0	21829	1365656	20.7	282929	1159275	9047963	716	3160000	654672	-504603	-7101815
2001	4055333	289667	527193	0	22920	1411034	21.8	306947	1146727	9191554	734	3265000	710246	-436481	-7156470
2002	3765667	289667	489537	0	24066	1454251	22.8	332166	1135435	9317374	756	3365000	768600	-366835	-7197120
2003	3476000	289667	451880	0	25270	1497468	24.0	359139	1125955	9427790	774	3465000	831013	-294942	-7226043
2004	3186333	289667	414223	0	26533	1542846	25.2	388523	1118946	9524894	792	3570000	899005	-219941	-7245130
2005	2896667	289667	376567	0	27860	1588224	26.4	419947	1114040	9610451	815	3675000	971718	-142322	-7256060
2006	2607000	289667	338910	0	29253	1667743	27.8	463022	1120851	9686628	856	3859000	1071389	-49462	-7259422
2007	2317333	289667	301253	0	30715	1751152	29.2	510488	1132123	9754719	899	4052000	1181221	49098	-7256469
2008	2027667	289667	263597	0	32251	1838450	30.6	562734	1148248	9815834	943	4254000	1302112	153864	-7248279
2009	1738000	289667	225940	0	33864	1930502	32.1	620455	1169926	9870940	991	4467000	1435675	265750	-7235762
2010	1448333	289667	188283	0	35557	2026876	33.7	684001	1197508	9920856	1040	4690000	1582714	385206	-7219705
2011	1158667	289667	150627	0	37335	2127572	35.4	753881	1231509	9966284	1092	4923000	1744411	512901	-7200785
2012	869000	289667	112970	0	39201	2234750	37.2	831452	1273290	10007849	1147	5171000	1923901	650611	-7179547
2013	579333	289667	75313	0	41161	2372828	39.1	926966	1333107	10046360	1204	5430000	2121277	788169	-7156778
2014	289667	289667	37657	0	43219	2546958	41.0	1044741	1415284	10082542	1264	5701000	2338502	923219	-7133176

CAPITAL COST HYDRO ($)	8690000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	6%

VERNILION FALLS HYDRO STUDY
1000 kW INSTALLATION

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	BEGINNING YEAR RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT WORTH ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	8690000	289667	1129700	0	10500	723884	10.1	72825	1502692	1329816	387	1675000	168511	-1334181	-1180691
1986	8400333	289667	1092043	0	11025	767101	10.7	81804	1474539	2484596	414	1775000	189286	-1285253	-2187233
1987	8110667	289667	1054387	0	11576	808157	11.3	91353	1446982	3487427	437	1870000	211382	-1235601	-3043566
1988	7821000	289667	1016730	0	12155	851374	12.0	102012	1420564	4358686	455	1970000	236046	-1184517	-3770053
1989	7531333	289667	979073	0	12763	892431	12.7	113347	1394850	5115755	477	2065000	262275	-1132575	-4384769
1990	7241667	289667	941417	0	13401	935648	13.5	125967	1370451	5774007	500	2165000	291475	-1078976	-4903021
1991	6952000	289667	903760	0	14071	968060	14.3	138150	1345648	6345989	527	2240000	319666	-1025981	-5339126
1992	6662333	289667	866103	0	14775	1022081	15.1	154611	1325156	6844460	549	2365000	357755	-967400	-5703023
1993	6372667	289667	828447	0	15513	1063138	16.0	170471	1304097	7278574	572	2460000	394453	-909644	-6005829
1994	6083000	289667	790790	0	16289	1104194	17.0	187677	1284423	7656950	590	2555000	434268	-850155	-6256275
1995	5793333	289667	753133	0	17103	1147411	18.0	206724	1266628	7987157	612	2655000	478340	-788287	-6461780
1996	5503667	289667	715477	0	17959	1190628	19.1	227381	1250483	8275651	635	2755000	526138	-724345	-6628891
1997	5214000	289667	677820	0	18856	1233845	20.2	249772	1236116	8528021	657	2855000	577950	-658166	-6763265
1998	4924333	289667	640163	0	19799	1277062	21.5	274032	1223662	8749108	680	2955000	634085	-589577	-6869787
1999	4634667	289667	602507	0	20789	1320279	22.7	300304	1213267	8943099	698	3055000	694876	-518391	-6952673
2000	4345000	289667	564850	0	21829	1365656	24.1	329263	1205609	9113688	716	3160000	761884	-443725	-7015459
2001	4055333	289667	527193	0	22920	1411034	25.6	360616	1200396	9263999	734	3265000	834432	-365965	-7061284
2002	3765667	289667	489537	0	24066	1454251	27.1	393961	1197230	9396667	756	3365000	911588	-285642	-7092937
2003	3476000	289667	451880	0	25270	1497468	28.7	430008	1196824	9514032	774	3465000	994999	-201826	-7112729
2004	3186333	289667	414223	0	26533	1542846	30.4	469621	1200044	9618175	792	3570000	1086659	-113385	-7122568
2005	2896667	289667	376567	0	27860	1588224	32.3	512440	1206533	9710834	815	3675000	1185737	-20796	-7124165
2006	2607000	289667	338910	0	29253	1667743	34.2	570382	1228212	9794308	856	3859000	1319811	91599	-7117940
2007	2317333	289667	301253	0	30715	1751152	36.3	634843	1256478	9869878	899	4052000	1468967	212489	-7105160
2008	2027667	289667	263597	0	32251	1838450	38.4	706481	1291995	9938645	943	4254000	1634730	342735	-7086918
2009	1738000	289667	225940	0	33864	1930502	40.7	786366	1335836	10001565	991	4467000	1819577	483741	-7064133
2010	1448333	289667	188283	0	35557	2026876	43.2	875160	1388667	10059449	1040	4690000	2025038	636371	-7037607
2011	1158667	289667	150627	0	37335	2127572	45.8	973757	1451384	10112987	1092	4923000	2253181	801796	-7008030
2012	869000	289667	112970	0	39201	2234750	48.5	1084179	1526017	10162803	1147	5171000	2508688	982671	-6975952
2013	579333	289667	75313	0	41161	2372828	51.4	1220237	1626378	10209786	1204	5430000	2792401	1166022	-6942267
2014	289667	289667	37657	0	43219	2546958	54.5	1388371	1758914	10254753	1264	5701000	3107669	1348756	-6907786

CAPITAL COST HYDRO ($) 8690000
LIFE (YEARS) 30
RETURN/DISCOUNT RATE 9%
INFLATION RATE 5%
FUEL ESCALATION RATE 5%

VERMILION FALLS HYDRO STUDY
1000 kW INSTALLATION

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	BEGINNING YEAR RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT WORTH ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	8690000	289667	782100	0	10500	723884	10.0	72138	1154405	1059087	387	1675000	166921	-987484	-905948
1986	8400333	289667	756030	0	11025	767101	10.5	80267	1136989	2016068	414	1775000	185731	-951258	-1706603
1987	8110667	289667	729960	0	11576	808157	11.0	88792	1119994	2880909	437	1870000	205455	-914539	-2412795
1988	7821000	289667	703890	0	12155	851374	11.5	98217	1103928	3662960	455	1970000	227264	-876664	-3033846
1989	7531333	289667	677820	0	12763	892431	12.1	108101	1088350	4370313	477	2065000	250135	-838215	-3578629
1990	7241667	289667	651750	0	13401	935648	12.7	119002	1073820	5010597	500	2165000	275360	-798460	-4054724
1991	6952000	289667	625680	0	14071	968060	13.4	129281	1058699	5589741	527	2240000	299144	-759554	-4470226
1992	6662333	289667	599610	0	14775	1022081	14.0	143320	1047372	6115382	549	2365000	331630	-715742	-4829433
1993	6372667	289667	573540	0	15513	1063138	14.7	156531	1035251	6592040	572	2460000	362198	-673053	-5139325
1994	6083000	289667	547470	0	16289	1104194	15.5	170705	1024131	7024644	590	2555000	394995	-629135	-5405079
1995	5793333	289667	521400	0	17103	1147411	16.2	186255	1014426	7417767	612	2655000	430978	-583448	-5631184
1996	5503667	289667	495330	0	17959	1190628	17.0	202934	1005889	7775396	635	2755000	469571	-536319	-5821864
1997	5214000	289667	469260	0	18856	1233845	17.9	220815	998598	8101117	657	2855000	510946	-487653	-5980926
1998	4924333	289667	443190	0	19799	1277062	18.8	239977	992633	8398159	680	2955000	555284	-437349	-6111801
1999	4634667	289667	417120	0	20789	1320279	19.7	260503	988079	8669425	698	3055000	602780	-385299	-6217580
2000	4345000	289667	391050	0	21829	1365656	20.7	282929	985475	8917636	716	3160000	654672	-330803	-6300899
2001	4055333	289667	364980	0	22920	1411034	21.8	306947	984514	9145131	734	3265000	710246	-274267	-6364275
2002	3765667	289667	338910	0	24066	1454251	22.8	332166	984808	9353904	756	3365000	768600	-216209	-6410110
2003	3476000	289667	312840	0	25270	1497468	24.0	359139	986915	9545849	774	3465000	831013	-155902	-6440432
2004	3186333	289667	286770	0	26533	1542846	25.2	388523	991492	9722762	792	3570000	899005	-92488	-6456934
2005	2896667	289667	260700	0	27860	1588224	26.4	419947	998174	9886161	815	3675000	971718	-26455	-6461265
2006	2607000	289667	234630	0	29253	1667743	27.8	463022	1016571	10038831	856	3859000	1071389	54818	-6453032
2007	2317333	289667	208560	0	30715	1751152	29.2	510488	1039430	10182045	899	4052000	1181221	141791	-6433496
2008	2027667	289667	182490	0	32251	1838450	30.6	562734	1067141	10316937	943	4254000	1302112	234971	-6403794
2009	1738000	289667	156420	0	33864	1930502	32.1	620455	1100406	10444549	991	4467000	1435675	335270	-6366914
2010	1448333	289667	130350	0	35557	2026876	33.7	684001	1139574	10565791	1040	4690000	1582714	443139	-6317767
2011	1158667	289667	104280	0	37335	2127572	35.4	753881	1185163	10681472	1092	4923000	1744411	559248	-6263180
2012	869000	289667	78210	0	39201	2234750	37.2	831452	1238530	10792380	1147	5171000	1923901	685371	-6201806
2013	579333	289667	52140	0	41161	2372828	39.1	926966	1309934	10899997	1204	5430000	2121277	811343	-6135151
2014	289667	289667	26070	0	43219	2546958	41.0	1044741	1403697	11005796	1264	5701000	2338502	934806	-6064694

14-Mar-85

CAPITAL COST HYDRO ($)	8690000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
1000 kW INSTALLATION

** HYDRO AVAILABLE ALL YEAR

* HYDRO DEVELOPMENT											* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	BEGINNING YEAR RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT WORTH ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	8690000	289667	1129700	0	10500	0	10.0	0	1429867	1265369	387	1675000	166921	-1262945	-1117651
1986	8400333	289667	1092043	0	11025	0	10.5	0	1392735	2356085	414	1775000	185731	-1207004	-2062912
1987	8110667	289667	1054387	0	11576	0	11.0	0	1355630	3295604	437	1870000	205455	-1150174	-2860040
1988	7821000	289667	1016730	0	12155	0	11.5	0	1318552	4104296	455	1970000	227264	-1091287	-3529347
1989	7531333	289667	979073	0	12763	0	12.1	0	1281503	4799845	477	2065000	250135	-1031368	-4089132
1990	7241667	289667	941417	0	13401	0	12.7	0	1244484	5397594	500	2165000	275360	-969124	-4554621
1991	6952000	289667	903760	0	14071	0	13.4	0	1207498	5910853	527	2240000	299144	-908353	-4940726
1992	6662333	289667	866103	0	14775	0	14.0	0	1170545	6351165	549	2365000	331630	-838915	-5256292
1993	6372667	289667	828447	0	15513	0	14.7	0	1133627	6728532	572	2460000	362198	-771428	-5513089
1994	6083000	289667	790790	0	16289	0	15.5	0	1096746	7051621	590	2555000	394995	-701751	-5719816
1995	5793333	289667	753133	0	17103	0	16.2	0	1059903	7327935	612	2655000	430978	-628926	-5883776
1996	5503667	289667	715477	0	17959	0	17.0	0	1023102	7563971	635	2755000	469571	-553531	-6011479
1997	5214000	289667	677820	0	18856	0	17.9	0	986343	7765347	657	2855000	510946	-475397	-6108538
1998	4924333	289667	640163	0	19799	0	18.8	0	949629	7936923	680	2955000	555284	-394345	-6179787
1999	4634667	289667	602507	0	20789	0	19.7	0	912963	8082897	698	3055000	602780	-310183	-6229382
2000	4345000	289667	564850	0	21829	0	20.7	0	876345	8206897	716	3160000	654672	-221674	-6260748
2001	4055333	289667	527193	0	22920	0	21.8	0	839780	8312052	734	3265000	710246	-129534	-6276968
2002	3765667	289667	489537	0	24066	0	22.8	0	803270	8401064	756	3365000	768600	-34670	-6280810
2003	3476000	289667	451880	0	25270	0	24.0	0	766816	8476261	774	3465000	831013	64197	-6274514
2004	3186333	289667	414223	0	26533	0	25.2	0	730423	8539649	792	3570000	899005	168582	-6259885
2005	2896667	289667	376567	0	27860	0	26.4	0	694093	8592954	815	3675000	971718	277625	-6238563
2006	2607000	289667	338910	0	29253	0	27.8	0	657829	8637663	856	3859000	1071389	413560	-6210456
2007	2317333	289667	301253	0	30715	0	29.2	0	621635	8675051	899	4052000	1181221	559586	-6176800
2008	2027667	289667	263597	0	32251	0	30.6	0	585514	8706215	943	4254000	1302112	716598	-6138659
2009	1738000	289667	225940	0	33864	0	32.1	0	549470	8732096	991	4467000	1435675	886205	-6096917
2010	1448333	289667	188283	0	35557	66881	33.7	22570	536077	8754441	1040	4690000	1582714	1046637	-6053290
2011	1158667	289667	150627	0	37335	153616	35.4	54432	532060	8774068	1092	4923000	1744411	1212351	-6008569
2012	869000	289667	112970	0	39201	245461	37.2	91325	533163	8791472	1147	5171000	1923901	1390738	-5963170
2013	579333	289667	75313	0	41161	341213	39.1	133298	539439	8807056	1204	5430000	2121277	1581838	-5917473
2014	289667	289667	37657	0	43219	441709	41.0	181185	551728	8821161	1264	5701000	2338502	1786774	-5871794

CAPITAL COST HYDRO ($)	8690000
LIFE (YEARS)	50
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
1000 kW INSTALLATION

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	BEGINNING YEAR RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT WORTH ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	8690000	173800	1129700	0	10500	723884	10.0	72138	1386138	1226671	387	1675000	166921	-1219217	-1078953
1986	8516200	173800	1107106	0	11025	767101	10.5	80267	1372198	2301304	414	1775000	185731	-1186467	-2008131
1987	8342400	173800	1084512	0	11576	808157	11.0	88792	1358680	3242937	437	1870000	205455	-1153225	-2807373
1988	8168600	173800	1061918	0	12155	851374	11.5	98217	1346090	4068519	455	1970000	227264	-1118826	-3493570
1989	7994800	173800	1039324	0	12763	892431	12.1	108101	1333988	4792554	477	2065000	250135	-1083853	-4081842
1990	7821000	173800	1016730	0	13401	935648	12.7	119002	1322933	5427984	500	2165000	275360	-1047573	-4585011
1991	7647200	173800	994136	0	14071	980060	13.4	129281	1311288	5985361	527	2240000	299144	-1012144	-5015233
1992	7473400	173800	971542	0	14775	1022081	14.0	143320	1303437	6475661	549	2365000	331630	-971807	-5380788
1993	7299600	173800	948948	0	15513	1063138	14.7	156531	1294793	6906678	572	2460000	362198	-932594	-5691234
1994	7125800	173800	926354	0	16289	1104194	15.5	170705	1287148	7285857	590	2555000	394995	-892153	-5954052
1995	6952000	173800	903760	0	17103	1147411	16.2	186255	1280919	7619789	612	2655000	430978	-849941	-6175630
1996	6778200	173800	881166	0	17959	1190628	17.0	202934	1275859	7914137	635	2755000	469571	-806288	-6361645
1997	6604400	173800	858572	0	18856	1233845	17.9	220815	1272044	8173844	657	2855000	510946	-761098	-6517034
1998	6430600	173800	835978	0	19799	1277062	18.8	239977	1269554	8403222	680	2955000	555284	-714270	-6646086
1999	6256800	173800	813384	0	20789	1320279	19.7	260503	1268476	8606040	698	3055000	602780	-665697	-6752525
2000	6083000	173800	790790	0	21829	1365656	20.7	282929	1269348	8785648	716	3160000	654672	-614676	-6839499
2001	5909200	173800	768196	0	22920	1411034	21.8	306947	1271863	8944908	734	3265000	710246	-561617	-6909824
2002	5735400	173800	745602	0	24066	1454251	22.8	332166	1275634	9086264	756	3365000	768600	-507034	-6966010
2003	5561600	173800	723008	0	25270	1497468	24.0	359139	1281216	9211905	774	3465000	831013	-450203	-7010158
2004	5387800	173800	700414	0	26533	1542846	25.2	388523	1289270	9323791	792	3570000	899005	-390265	-7044026
2005	5214000	173800	677820	0	27860	1588224	26.4	419947	1299427	9423585	815	3675000	971718	-327709	-7069194
2006	5040200	173800	655226	0	29253	1667743	27.8	463022	1321301	9513385	856	3859000	1071389	-249912	-7086179
2007	4866400	173800	632632	0	30715	1751152	29.2	510488	1347635	9594438	899	4052000	1181221	-166414	-7096188
2008	4692600	173800	610038	0	32251	1838450	30.6	562734	1378823	9667826	943	4254000	1302112	-76710	-7100270
2009	4518800	173800	587444	0	33864	1930502	32.1	620455	1415563	9734501	991	4467000	1435675	20112	-7099323
2010	4345000	173800	564850	0	35557	2026876	33.7	684001	1458208	9795284	1040	4690000	1582714	124506	-7094133
2011	4171200	173800	542256	0	37335	2127572	35.4	753881	1507272	9850884	1092	4923000	1744411	237139	-7085386
2012	3997400	173800	519662	0	39201	2234750	37.2	831452	1564115	9901943	1147	5171000	1923901	359786	-7073641
2013	3823600	173800	497068	0	41161	2372828	39.1	926966	1638995	9949291	1204	5430000	2121277	482281	-7059709
2014	3649800	173800	474474	0	43219	2546958	41.0	1044741	1736234	9993678	1264	5701000	2338502	602268	-7044312
2015	3476000	173800	451880	0	45380	2730192	43.1	1175897	1846957	10035464	1327	5986050	2578199	731242	-7027768
2016	3302200	173800	429286	0	47649	2922587	45.2	1321700	1972435	10074954	1394	6285353	2842464	870029	-7010349
2017	3128400	173800	406692	0	50032	3124602	47.5	1483711	2114235	10112414	1463	6599620	3133817	1019582	-6992284
2018	2954600	173800	384098	0	52533	3336719	49.9	1663656	2274088	10148070	1536	6929601	3455033	1180946	-6973767
2019	2780800	173800	361504	0	55160	3559440	52.4	1863438	2453902	10182120	1613	7276081	3809174	1355272	-6954962
2020	2607000	173800	338910	0	57918	3793298	55.0	2085161	2655789	10214731	1694	7639885	4199614	1543825	-6936005
2021	2433200	173800	316316	0	60814	4038849	57.7	2331146	2882076	10246050	1779	8021880	4630075	1747999	-6917010

2022	2259400	173800	293722	0	63855	4296677	60.6	2603958	3135334	10276201	1868	8422973	5104658	1969323	-6898072
2023	2085600	173800	271128	0	67048	4567397	63.6	2906426	3418401	10305292	1961	8844122	5627885	2209484	-6879269
2024	1911800	173800	248534	0	70400	4851653	66.8	3241675	3734409	10333417	2059	9286328	6204743	2470334	-6860664
2025	1738000	173800	225940	0	73920	5150121	70.2	3613155	4086815	10360655	2162	9750645	6840729	2753915	-6842310
2026	1564200	173800	203346	0	77616	5463513	73.7	4024671	4479433	10387074	2270	10238177	7541904	3062471	-6824248
2027	1390400	173800	180752	0	81497	5792575	77.3	4480426	4916475	10412736	2383	10750086	8314949	3398474	-6806509
2028	1216600	173800	158158	0	85572	6138090	81.2	4985058	5402587	10437690	2503	11287590	9167232	3764644	-6789120
2029	1042800	173800	135564	0	89850	6500880	85.3	5543683	5942898	10461983	2628	11851970	10106873	4163975	-6772100
2030	869000	173800	112970	0	94343	6881810	89.5	6161951	6543064	10485651	2759	12444568	11142827	4599764	-6755461
2031	695200	173800	90376	0	99060	7281786	94.0	6846093	7209329	10508730	2897	13066796	12284967	5075638	-6739213
2032	521400	173800	67782	0	104013	7864136	98.7	7763279	8108874	10531701	3042	13720136	13544176	5435302	-6723815
2033	347600	173800	45188	0	109213	8550143	103.7	8862512	9190714	10554743	3194	14406143	14932454	5741741	-6709420
2034	173800	173800	22594	0	114674	9270450	108.8	10089592	10400660	10577818	3354	15126450	16463031	6062371	-6695970

ECONOMIC ANALYSES

	Return/ Discount Rate	Inflation Rate	Fuel Escalation Rate	Page
500 kW Installation Serving Both Communities				
- 30 Year Analysis	13	5	4	C-12
	13	5	5	C-13
	13	5	6	C-14
	9	5	5	C-15
- 12 month operation	13	5	5	C-16
- 50 Year Analysis	13	5	5	C-17

CAPITAL COST HYDRO ($)	6400000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	4%

VERNILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE FOX LAKE AND JOHN D'OR PRAIRIE

	HYDRO DEVELOPMENT										LOAD DATA		DIESEL	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	6400000	213333	832000	0	10500	723884	9.9	71451	1127285	997597	387	1675000	165332	-961953	-851286
1986	6186667	213333	804267	0	11025	767101	10.3	78746	1107371	1864831	414	1775000	182210	-925160	-1575822
1987	5973333	213333	776533	0	11576	808157	10.7	86279	1087722	2618676	437	1870000	199641	-888081	-2191307
1988	5760000	213333	748800	0	12155	851374	11.1	94528	1068817	3274202	455	1970000	218730	-850087	-2712681
1989	5546667	213333	721067	0	12763	892431	11.5	103050	1050213	3844215	477	2065000	238448	-811765	-3153274
1990	5333333	213333	693333	0	13401	935648	12.0	112362	1032430	4340110	500	2165000	259995	-772434	-3524289
1991	5120000	213333	665600	0	14071	968060	12.5	120905	1013909	4771083	527	2240000	279762	-734147	-3836346
1992	4906667	213333	637867	0	14775	1022081	13.0	132758	998732	5146766	549	2365000	307189	-691543	-4096477
1993	4693333	213333	610133	0	15513	1063138	13.5	143614	982594	5473857	572	2460000	332310	-650284	-4312947
1994	4480000	213333	582400	0	16289	1105570	14.0	155320	967342	5758825	590	2555000	358948	-608394	-4492172
1995	4266667	213333	554667	0	17103	1166119	14.6	170380	955483	6007917	612	2655000	387917	-567566	-4640135
1996	4053333	213333	526933	0	17959	1227458	15.2	186515	944741	6225874	635	2755000	418629	-526111	-4761512
1997	3840000	213333	499200	0	18856	1288452	15.8	203615	935005	6416769	657	2855000	451177	-483827	-4860293
1998	3626667	213333	471467	0	19799	1349941	16.4	221865	926465	6584159	680	2955000	485660	-440805	-4939936
1999	3413333	213333	443733	0	20789	1410694	17.1	241124	918980	6731096	698	3055000	522179	-396802	-5003381
2000	3200000	213333	416000	0	21829	1475327	17.8	262258	913421	6860341	716	3160000	561731	-351690	-5053143
2001	2986667	213333	388267	0	22920	1540959	18.5	284882	909403	6974215	734	3265000	603612	-305791	-5091434
2002	2773333	213333	360533	0	24066	1604234	19.2	308444	906376	7074653	756	3365000	646983	-259393	-5120178
2003	2560000	213333	332800	0	25270	1668059	20.0	333544	904947	7163395	774	3465000	692858	-212088	-5140976
2004	2346667	213333	305067	0	26533	1735912	20.8	360996	905929	7242014	792	3570000	742408	-163521	-5155167
2005	2133333	213333	277333	0	27860	1803432	21.6	390039	908565	7311790	815	3675000	794814	-113751	-5163903
2006	1920000	213333	249600	0	29253	1921602	22.5	432220	924406	7374616	856	3859000	867993	-56413	-5167737
2007	1706667	213333	221867	0	30715	2045499	23.4	478491	944406	7431417	899	4052000	947860	3453	-5167529
2008	1493333	213333	194133	0	32251	2175783	24.3	529326	969044	7482994	943	4254000	1034917	65873	-5164023
2009	1280000	213333	166400	0	33864	2312117	25.3	584994	998591	7530030	991	4467000	1130205	131614	-5157824
2010	1066667	213333	138667	0	35557	2455794	26.3	646199	1033756	7573120	1040	4690000	1234092	200336	-5149473
2011	853333	213333	110933	0	37335	2605204	27.4	712935	1074536	7612757	1092	4923000	1347218	272682	-5139414
2012	640000	213333	83200	0	39201	2764551	28.5	786803	1122537	7649401	1147	5171000	1471688	349151	-5128017
2013	426667	213333	55467	0	41161	2931510	29.6	867693	1177654	7683422	1204	5430000	1607217	429563	-5115607
2014	213333	213333	27733	0	43219	3105817	30.8	956057	1240343	7715131	1264	5701000	1754927	514584	-5102452

CAPITAL COST HYDRO ($)	6400000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE FOX LAKE AND JOHN D'OR PRAIRIE

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	6400000	213333	832000	0	10500	723884	10.0	72138	1127972	998205	387	1675000	166921	-961050	-850487
1986	6186667	213333	804267	0	11025	767101	10.5	80267	1108892	1866630	414	1775000	185731	-923161	-1573458
1987	5973333	213333	776533	0	11576	808157	11.0	88792	1090234	2622218	437	1870000	205455	-884779	-2186654
1988	5760000	213333	748800	0	12155	851374	11.5	98217	1072505	3280005	455	1970000	227264	-845241	-2705056
1989	5546667	213333	721067	0	12763	892431	12.1	108101	1055264	3852760	477	2065000	250135	-805129	-3142048
1990	5333333	213333	693333	0	13401	935648	12.7	119002	1039070	4351845	500	2165000	275360	-763710	-3508872
1991	5120000	213333	665600	0	14071	968060	13.4	129281	1022286	4786378	527	2240000	299144	-723141	-3816250
1992	4906667	213333	637867	0	14775	1022081	14.0	143320	1009295	5166034	549	2365000	331630	-677665	-4071161
1993	4693333	213333	610133	0	15513	1063138	14.7	156531	995511	5497425	572	2460000	362198	-633313	-4281981
1994	4480000	213333	582400	0	16289	1105570	15.5	170918	982940	5786987	590	2555000	394995	-587945	-4455183
1995	4266667	213333	554667	0	17103	1166119	16.2	189292	974396	6041010	612	2655000	430978	-543418	-4596851
1996	4053333	213333	526933	0	17959	1227458	17.0	209212	967437	6264203	635	2755000	469571	-497866	-4711711
1997	3840000	213333	499200	0	18856	1288452	17.9	230588	961978	6460605	657	2855000	510946	-451032	-4803796
1998	3626667	213333	471467	0	19799	1349941	18.8	253672	958271	6633742	680	2955000	555284	-402987	-4876606
1999	3413333	213333	443733	0	20789	1410694	19.7	278343	956199	6786630	698	3055000	602780	-353419	-4933115
2000	3200000	213333	416000	0	21829	1475327	20.7	305650	956812	6922015	716	3160000	654672	-302140	-4975867
2001	2986667	213333	388267	0	22920	1540959	21.8	335210	959730	7042190	734	3265000	710246	-249484	-5007106
2002	2773333	213333	360533	0	24066	1604234	22.8	366423	964356	7149053	756	3365000	768600	-195756	-5028799
2003	2560000	213333	332800	0	25270	1668059	24.0	400052	971454	7244318	774	3465000	831013	-140442	-5042571
2004	2346667	213333	305067	0	26533	1735912	25.2	437141	982074	7329544	792	3570000	899005	-83069	-5049780
2005	2133333	213333	277333	0	27860	1803432	26.4	476851	995377	7405988	815	3675000	971718	-23659	-5051597
2006	1920000	213333	249600	0	29253	1921602	27.8	533502	1025688	7475697	856	3859000	1071389	45701	-5048491
2007	1706667	213333	221867	0	30715	2045499	29.2	596295	1062210	7539583	899	4052000	1181221	119011	-5041333
2008	1493333	213333	194133	0	32251	2175783	30.6	665988	1105706	7598434	943	4254000	1302112	196406	-5030879
2009	1280000	213333	166400	0	33864	2312117	32.1	743105	1156702	7652917	991	4467000	1435675	278973	-5017739
2010	1066667	213333	138667	0	35557	2455794	33.7	828746	1216303	7703617	1040	4690000	1582714	366411	-5002466
2011	853333	213333	110933	0	37335	2605204	35.4	923125	1284727	7751007	1092	4923000	1744411	459684	-4985509
2012	640000	213333	83200	0	39201	2764551	37.2	1028568	1364302	7795544	1147	5171000	1923901	559599	-4967241
2013	426667	213333	55467	0	41161	2931510	39.1	1145220	1455181	7837582	1204	5430000	2121277	666095	-4947999
2014	213333	213333	27733	0	43219	3105817	41.0	1273980	1558266	7877419	1264	5701000	2338502	780236	-4928052

CAPITAL COST HYDRO ($)	6400000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	6%

VERNILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE FOX LAKE AND JOHN D'OR PRAIRIE

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	6400000	213333	832000	0	10500	723884	10.1	72825	1128659	998813	387	1675000	168511	-960148	-849688
1986	6186667	213333	804267	0	11025	767101	10.7	81804	1110429	1868441	414	1775000	189286	-921143	-1571078
1987	5973333	213333	776533	0	11576	808157	11.3	91353	1092796	2625804	437	1870000	211382	-881414	-2181942
1988	5760000	213333	748800	0	12155	851374	12.0	102012	1076301	3285919	455	1970000	236046	-840254	-2697286
1989	5546667	213333	721067	0	12763	892431	12.7	113347	1060510	3861521	477	2065000	262275	-798235	-3130536
1990	5333333	213333	693333	0	13401	935648	13.5	125967	1046034	4363951	500	2165000	291475	-754559	-3492965
1991	5120000	213333	665600	0	14071	968060	14.3	138150	1031154	4802254	527	2240000	319666	-711488	-3795390
1992	4906667	213333	637867	0	14775	1022081	15.1	154611	1020586	5186157	549	2365000	357755	-662830	-4044721
1993	4693333	213333	610133	0	15513	1063138	16.0	170471	1009451	5522188	572	2460000	394453	-614997	-4249444
1994	4480000	213333	582400	0	16289	1105570	17.0	187911	999934	5816757	590	2555000	434268	-565666	-4416082
1995	4266667	213333	554667	0	17103	1166119	18.0	210095	995198	6076203	612	2655000	478340	-516858	-4550826
1996	4053333	213333	526933	0	17959	1227458	19.1	234415	992640	6305211	635	2755000	526138	-466502	-4658451
1997	3840000	213333	499200	0	18856	1288452	20.2	260827	992217	6507786	657	2855000	577950	-414267	-4743029
1998	3626667	213333	471467	0	19799	1349941	21.5	289671	994270	6687427	680	2955000	634085	-360185	-4808106
1999	3413333	213333	443733	0	20789	1410694	22.7	320870	998726	6847114	698	3055000	694876	-303850	-4856689
2000	3200000	213333	416000	0	21829	1475327	24.1	355705	1006867	6989582	716	3169000	761884	-244983	-4891353
2001	2986667	213333	388267	0	22920	1540959	25.6	393821	1018341	7117097	734	3265000	834432	-183909	-4914382
2002	2773333	213333	360533	0	24066	1604234	27.1	434591	1032524	7231513	756	3365000	911588	-120937	-4927783
2003	2560000	213333	332800	0	25270	1668059	28.7	478995	1050398	7334519	774	3465000	994999	-55399	-4933216
2004	2346667	213333	305067	0	26533	1735912	30.4	528388	1073321	7427665	792	3570000	1086659	13338	-4932059
2005	2133333	213333	277333	0	27860	1803432	32.3	581876	1100403	7512174	815	3675000	1185737	85334	-4925505
2006	1920000	213333	249600	0	29253	1921602	34.2	657204	1149390	7590290	856	3859000	1319811	170421	-4913923
2007	1706667	213333	221867	0	30715	2045499	36.3	741553	1207468	7662913	899	4052000	1468967	261500	-4898195
2008	1493333	213333	194133	0	32251	2175783	38.4	836112	1275829	7730819	943	4254000	1634730	358901	-4879092
2009	1280000	213333	166400	0	33864	2312117	40.7	941812	1355409	7794662	991	4467000	1819577	464168	-4857229
2010	1066667	213333	138667	0	35557	2455794	43.2	1060357	1447914	7855015	1040	4690000	2025038	577124	-4833173
2011	853333	213333	110933	0	37335	2605204	45.8	1192362	1553963	7912337	1092	4923000	2253181	699218	-4807380
2012	640000	213333	83200	0	39201	2764551	48.5	1341210	1676944	7967079	1147	5171000	2508688	831743	-4780229
2013	426667	213333	55467	0	41161	2931510	51.4	1507542	1817503	8019584	1204	5430000	2792401	974898	-4752065
2014	213333	213333	27733	0	43219	3105817	54.5	1693010	1977296	8070134	1264	5701000	3107669	1130373	-4723167

CAPITAL COST HYDRO ($)	6400000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	9%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE FOX LAKE AND JOHN D'OR PRAIRIE

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	6400000	213333	576000	0	10500	723884	10.0	72138	871972	799974	387	1675000	166921	-705050	-646835
1986	6186667	213333	556800	0	11025	767101	10.5	80267	861426	1525019	414	1775000	185731	-675695	-1215554
1987	5973333	213333	537600	0	11576	808157	11.0	88792	851301	2182380	437	1870000	205455	-645846	-1714265
1988	5760000	213333	518400	0	12155	851374	11.5	98217	842105	2778948	455	1970000	227264	-614841	-2149834
1989	5546667	213333	499200	0	12763	892431	12.1	108101	833397	3320599	477	2065000	250135	-583262	-2528914
1990	5333333	213333	480000	0	13401	935648	12.7	119002	825737	3812959	500	2165000	275360	-550376	-2857086
1991	5120000	213333	460800	0	14071	968060	13.4	129281	817486	4260151	527	2240000	299144	-518341	-3140636
1992	4906667	213333	441600	0	14775	1022081	14.0	143320	813028	4668183	549	2365000	331630	-481399	-3382234
1993	4693333	213333	422400	0	15513	1063138	14.7	156531	807778	5040106	572	2460000	362198	-445579	-3587391
1994	4480000	213333	403200	0	16289	1105570	15.5	170918	803740	5379614	590	2555000	394995	-408745	-3760049
1995	4266667	213333	384000	0	17103	1166119	16.2	189292	803729	5691086	612	2655000	430978	-372752	-3904503
1996	4053333	213333	364800	0	17959	1227458	17.0	209212	805304	5977399	635	2755000	469571	-335733	-4023867
1997	3840000	213333	345600	0	18856	1288452	17.9	230588	808378	6241075	657	2855000	510946	-297432	-4120883
1998	3626667	213333	326400	0	19799	1349941	18.8	253672	813205	6484424	680	2955000	555284	-257920	-4198065
1999	3413333	213333	307200	0	20789	1410694	19.7	278343	819666	6709453	698	3055000	602780	-216886	-4257608
2000	3200000	213333	288000	0	21829	1475327	20.7	305650	828812	6918206	716	3160000	654672	-174140	-4301469
2001	2986667	213333	268800	0	22920	1540959	21.8	335210	840264	7112368	734	3265000	710246	-130017	-4331513
2002	2773333	213333	249600	0	24066	1604234	22.8	366423	853423	7293288	756	3365000	768600	-84823	-4349495
2003	2560000	213333	230400	0	25270	1668059	24.0	400052	869054	7462310	774	3465000	831013	-38042	-4356893
2004	2346667	213333	211200	0	26533	1735912	25.2	437141	888207	7620794	792	3570000	899005	10797	-4354967
2005	2133333	213333	192000	0	27860	1803432	26.4	476851	910044	7769767	815	3675000	971718	61674	-4344871
2006	1920000	213333	172800	0	29253	1921602	27.8	533502	948888	7912272	856	3859000	1071389	122501	-4326473
2007	1706667	213333	153600	0	30715	2045499	29.2	596295	993943	8049219	899	4052000	1181221	187278	-4300670
2008	1493333	213333	134400	0	32251	2175783	30.6	665988	1045973	8181435	943	4254000	1302112	256140	-4268293
2009	1280000	213333	115200	0	33864	2312117	32.1	743105	1105502	8309638	991	4467000	1435675	330173	-4230003
2010	1066667	213333	96000	0	35557	2455794	33.7	828746	1173636	8434504	1040	4690000	1582714	409078	-4186480
2011	853333	213333	76800	0	37335	2605204	35.4	923125	1250593	8556572	1092	4923000	1744411	493817	-4138280
2012	640000	213333	57600	0	39201	2764551	37.2	1028568	1338702	8676450	1147	5171000	1923901	585199	-4085876
2013	426667	213333	38400	0	41161	2931510	39.1	1145220	1438115	8794598	1204	5430000	2121277	683162	-4029751
2014	213333	213333	19200	0	43219	3105817	41.0	1273980	1549733	8911403	1264	5701000	2338502	788770	-3970301

CAPITAL COST HYDRO ($)	6400000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE FOX LAKE AND JOHN D'OR PRAIRIE

** HYDRO AVAILABLE ALL YEAR

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	6400000	213333	832000	0	10500	0	10.0	0	1055833	934366	387	1675000	166921	-888912	-786648
1986	6186667	213333	804267	0	11025	0	10.5	0	1028625	1739930	414	1775000	185731	-842894	-1446757
1987	5973333	213333	776533	0	11576	0	11.0	0	1001443	2433980	437	1870000	205455	-795988	-1998417
1988	5760000	213333	748800	0	12155	0	11.5	0	974288	3031530	455	1970000	227264	-747024	-2456580
1989	5546667	213333	721067	0	12763	0	12.1	0	947163	3545612	477	2065000	250135	-697028	-2834899
1990	5333333	213333	693333	0	13401	0	12.7	0	920068	3987537	500	2165000	275360	-644707	-3144564
1991	5120000	213333	665600	0	14071	33483	13.4	4472	897476	4369019	527	2240000	299144	-598331	-3398891
1992	4906667	213333	637867	0	14775	65450	14.0	9178	875152	4698216	549	2365000	331630	-543523	-3603343
1993	4693333	213333	610133	0	15513	95316	14.7	14034	853014	4982171	572	2460000	362198	-490815	-3766728
1994	4480000	213333	582400	0	16289	123616	15.5	19111	831133	5227013	590	2555000	394995	-436138	-3895209
1995	4266667	213333	554667	0	17103	155276	16.2	25205	810309	5438259	612	2655000	430978	-379331	-3994100
1996	4053333	213333	526933	0	17959	187241	17.0	31914	790139	5620549	635	2755000	469571	-320568	-4068057
1997	3840000	213333	499200	0	18856	219567	17.9	39295	770685	5777895	657	2855000	510946	-259739	-4121086
1998	3626667	213333	471467	0	19799	251756	18.8	47308	751908	5913747	680	2955000	555284	-196623	-4156611
1999	3413333	213333	443733	0	20789	287229	19.7	56673	734529	6031192	698	3055000	602780	-131749	-4177677
2000	3200000	213333	416000	0	21829	326523	20.7	67647	718809	6132901	716	3160000	654672	-64137	-4186752
2001	2986667	213333	388267	0	22920	367313	21.8	79903	704423	6221107	734	3265000	710246	5823	-4186023
2002	2773333	213333	360533	0	24066	403054	22.8	92062	689994	6297567	756	3365000	768600	78605	-4177312
2003	2560000	213333	332800	0	25270	443124	24.0	106275	677677	6364023	774	3465000	831013	153335	-4162276
2004	2346667	213333	305067	0	26533	487239	25.2	122698	667630	6421961	792	3570000	899005	231374	-4142196
2005	2133333	213333	277333	0	27860	526471	26.4	139206	657732	6472474	815	3675000	971718	313986	-4118083
2006	1920000	213333	249600	0	29253	594388	27.8	165022	657208	6517140	856	3859000	1071389	414181	-4089934
2007	1706667	213333	221867	0	30715	665552	29.2	194019	659934	6556831	899	4052000	1181221	521287	-4058581
2008	1493333	213333	194133	0	32251	741829	30.6	227067	666785	6592321	943	4254000	1302112	635327	-4024766
2009	1280000	213333	166400	0	33864	819289	32.1	263316	676913	6624205	991	4467900	1435675	758762	-3989027
2010	1066667	213333	138667	0	35557	902894	33.7	304696	692252	6653060	1040	4690000	1582714	890462	-3951909
2011	853333	213333	110933	0	37335	988484	35.4	350258	711860	6679319	1092	4923000	1744411	1032551	-3913821
2012	640000	213333	83200	0	39201	1080363	37.2	401956	737690	6703400	1147	5171000	1923901	1186211	-3875098
2013	426667	213333	55467	0	41161	1177518	39.1	460008	769969	6725644	1204	5430000	2121277	1351308	-3836061
2014	213333	213333	27733	0	43219	1318000	41.0	540633	824919	6746733	1264	5701000	2338502	1513584	-3797366

ECONOMIC ANALYSES

	Return/ Discount Rate	Inflation Rate	Fuel Escalation Rate	Page
500 kW Installation Serving John D'Or Prairie				
- 30 Year Analysis	13	5	4	C-18
	13	5	5	C-19
	13	5	6	C-20
	9	5	5	C-21
- 12 month operation	13	5	5	C-22

CAPITAL COST HYDRO ($)	5950000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	4%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	5950000	198333	773500	0	10500	367344	9.9	36259	1018592	901409	215	850000	83900	-934693	-827162
1986	5751667	198333	747717	0	11025	391114	10.3	40149	997224	1682382	230	905000	92902	-904323	-1535379
1987	5553333	198333	721933	0	11576	414883	10.7	44293	976136	2358893	245	960000	102489	-873646	-2140860
1988	5355000	198333	696150	0	12155	438652	11.1	48704	955342	2944822	255	1015000	112696	-842646	-2657670
1989	5156667	198333	670367	0	12763	462422	11.5	53396	934859	3452226	270	1070000	123554	-811305	-3098014
1990	4958333	198333	644583	0	13401	486191	12.0	58387	914704	3891576	285	1125000	135102	-779603	-3472472
1991	4760000	198333	618800	0	14071	509960	12.5	63691	894895	4271961	300	1180000	147375	-747520	-3790213
1992	4561667	198333	593017	0	14775	535890	13.0	69607	877331	4601375	315	1240000	161063	-714668	-4059043
1993	4363333	198333	567233	0	15513	559660	13.5	75602	856682	4886552	330	1295000	174935	-681746	-4285986
1994	4165000	198333	541450	0	16289	581268	14.0	81662	837734	5133338	340	1345000	188957	-648777	-4477108
1995	3966667	198333	515667	0	17103	607198	14.6	88717	819820	5347064	355	1405000	205282	-614538	-4637317
1996	3768333	198333	489883	0	17959	630968	15.2	95877	802052	5532102	370	1460000	221851	-580202	-4771173
1997	3570000	198333	464100	0	18856	654737	15.8	103469	784758	5692322	380	1515000	239416	-545342	-4882512
1998	3371667	198333	438317	0	19799	678507	16.4	111514	767963	5831075	395	1570000	258032	-509931	-4974644
1999	3173333	198333	412533	0	20789	702276	17.1	120037	751693	5951263	405	1625000	277755	-473938	-5050423
2000	2975000	198333	386750	0	21829	728206	17.8	129648	736360	6055455	415	1685000	299531	-436830	-5112233
2001	2776667	198333	360967	0	22920	751975	18.5	139020	721240	6145768	425	1740000	321680	-399561	-5162265
2002	2578333	198333	335183	0	24066	775745	19.2	149151	706734	6224083	435	1795000	345122	-361612	-5202336
2003	2380000	198333	309400	0	25270	799514	20.0	159870	692873	6292028	445	1850000	369924	-322949	-5234005
2004	2181667	198333	283617	0	26533	823283	20.8	171208	679691	6351014	455	1905000	396159	-283532	-5258611
2005	1983333	198333	257833	0	27860	849214	21.6	183664	667691	6402291	465	1965000	424982	-242709	-5277251
2006	1785000	198333	232050	0	29253	891566	22.5	200537	660173	6447159	488	2063000	464024	-196149	-5290582
2007	1586667	198333	206267	0	30715	913137	23.4	213605	648920	6486188	513	2166000	506679	-142241	-5299137
2008	1388333	198333	180483	0	32251	912955	24.3	222105	633172	6519888	538	2275000	553464	-79708	-5303379
2009	1190000	198333	154700	0	33864	905803	25.3	229179	616076	6548907	565	2388000	604193	-11883	-5303939
2010	991667	198333	128917	0	35557	907931	26.3	238906	601713	6573988	593	2509000	660200	58487	-5301501
2011	793333	198333	103133	0	37335	972654	27.4	266174	604976	6596304	623	2633000	720541	115566	-5297238
2012	595000	198333	77350	0	39201	1041580	28.5	296438	611323	6616260	654	2765000	786931	175608	-5291505
2013	396667	198333	51567	0	41161	1113437	29.6	329564	620626	6634189	687	2903000	859254	238628	-5284612
2014	198333	198333	25783	0	43219	1189252	30.8	366085	633421	6650383	721	3048000	938259	304838	-5276819

CAPITAL COST HYDRO ($)	5950000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	5950000	198333	773500	0	10500	367344	10.0	36608	1018941	901718	215	850000	84706	-934234	-826756
1986	5751667	198333	747717	0	11025	391114	10.5	40925	998000	1683298	230	905000	94697	-903303	-1534175
1987	5553333	198333	721933	0	11576	414883	11.0	45583	977426	2360703	245	960000	105474	-871951	-2138481
1988	5355000	198333	696150	0	12155	438652	11.5	50604	957242	2947798	255	1015000	117093	-840149	-2653761
1989	5156667	198333	670367	0	12763	462422	12.1	56013	937476	3456622	270	1070000	129610	-807866	-3092238
1990	4958333	198333	644583	0	13401	486191	12.7	61837	918155	3897629	285	1125000	143086	-775069	-3464518
1991	4760000	198333	618800	0	14071	509960	13.4	68103	899308	4279890	300	1180000	157585	-741723	-3779795
1992	4561667	198333	593017	0	14775	535890	14.0	75145	881269	4611388	315	1240000	173878	-707392	-4045888
1993	4363333	198333	567233	0	15513	559660	14.7	82402	863482	4898828	330	1295000	190670	-672812	-4269857
1994	4165000	198333	541450	0	16289	581268	15.5	89862	845935	5148030	340	1345000	207933	-638002	-4457805
1995	3966667	198333	515667	0	17103	607198	16.2	98565	829668	5364323	355	1405000	228069	-601599	-4614640
1996	3768333	198333	489883	0	17959	630968	17.0	107544	813719	5552052	370	1460000	248847	-564872	-4744959
1997	3570000	198333	464100	0	18856	654737	17.9	117175	798465	5715071	380	1515000	271132	-527333	-4852622
1998	3371667	198333	438317	0	19799	678507	18.8	127501	783950	5856712	395	1570000	295024	-488926	-4940959
1999	3173333	198333	412533	0	20789	702276	19.7	138565	770221	5979863	405	1625000	320627	-449594	-5012845
2000	2975000	198333	386750	0	21829	728206	20.7	150866	757778	6087086	415	1685000	349089	-408689	-5070673
2001	2776667	198333	360967	0	22920	751975	21.8	163580	745800	6180473	425	1740000	378508	-367292	-5116665
2002	2578333	198333	335183	0	24066	775745	22.8	177188	734771	6261895	435	1795000	409996	-324775	-5152654
2003	2380000	198333	309400	0	25270	799514	24.0	191748	724751	6332967	445	1850000	443687	-281064	-5180216
2004	2181667	198333	283617	0	26533	823283	25.2	207321	715804	6395086	455	1905000	479721	-236083	-5200704
2005	1983333	198333	257833	0	27860	849214	26.4	224543	708570	6449503	465	1965000	519572	-188998	-5215219
2006	1785000	198333	232050	0	29253	891566	27.8	247529	707165	6497564	488	2063000	572759	-134406	-5224353
2007	1586667	198333	206267	0	30715	913137	29.2	266194	701509	6539756	513	2166000	631423	-70086	-5228569
2008	1388333	198333	180483	0	32251	912955	30.6	279448	690515	6576509	538	2275000	696358	5842	-5228258
2009	1190000	198333	154700	0	33864	905803	32.1	291121	678018	6608445	565	2388000	767493	89475	-5224043
2010	991667	198333	128917	0	35557	907931	33.7	306395	669202	6636340	593	2509000	846701	177499	-5216644
2011	793333	198333	103133	0	37335	972654	35.4	344649	683450	6661551	623	2633000	932974	249524	-5207440
2012	595000	198333	77350	0	39201	1041580	37.2	387526	702410	6684480	654	2765000	1028735	326324	-5196788
2013	396667	198333	51567	0	41161	1113437	39.1	434974	726035	6705454	687	2903000	1134082	408047	-5185000
2014	198333	198333	25783	0	43219	1189252	41.0	487821	755157	6724760	721	3048000	1250264	495107	-5172342

14-Mar-85

CAPITAL COST HYDRO ($)	5950000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	6%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	5950000	198333	773500	0	10500	367344	10.1	36956	1019290	902026	215	850000	85513	-933776	-826351
1986	5751667	198333	747717	0	11025	391114	10.7	41708	998783	1684220	230	905000	96509	-902274	-1532964
1987	5553333	198333	721933	0	11576	414883	11.3	46898	978741	2362536	245	960000	108517	-870224	-2136073
1988	5355000	198333	696150	0	12155	438652	12.0	52560	959198	2950830	255	1015000	121618	-837580	-2649776
1989	5156667	198333	670367	0	12763	462422	12.7	58732	940195	3461130	270	1070000	135900	-804294	-3086315
1990	4958333	198333	644583	0	13401	486191	13.5	65456	921774	3903875	285	1125000	151459	-770315	-3456311
1991	4760000	198333	618800	0	14071	509960	14.3	72776	903980	4288122	300	1180000	168396	-735584	-3768979
1992	4561667	198333	593017	0	14775	535890	15.1	81065	887189	4621847	315	1240000	187576	-699613	-4032146
1993	4363333	198333	567233	0	15513	559660	16.0	89740	870820	4911729	330	1295000	207649	-663170	-4252905
1994	4165000	198333	541450	0	16289	581268	17.0	98797	854869	5163564	340	1345000	228607	-626263	-4437395
1995	3966667	198333	515667	0	17103	607198	18.0	109396	840500	5382680	355	1405000	253133	-587367	-4590520
1996	3768333	198333	489883	0	17959	630968	19.1	120500	826675	5573399	370	1460000	278825	-547850	-4716912
1997	3570000	198333	464100	0	18856	654737	20.2	132541	813831	5739554	380	1515000	306688	-507143	-4820453
1998	3371667	198333	438317	0	19799	678507	21.5	145594	802043	5884465	395	1570000	336891	-465152	-4904495
1999	3173333	198333	412533	0	20789	702276	22.7	159736	791392	6011001	405	1625000	369615	-421778	-4971933
2000	2975000	198333	386750	0	21829	728206	24.1	175572	782484	6121720	415	1685000	406258	-376227	-5025168
2001	2776667	198333	360967	0	22920	751975	25.6	192181	774401	6218688	425	1740000	444689	-329712	-5066454
2002	2578333	198333	335183	0	24066	775745	27.1	210151	767734	6303763	435	1795000	486270	-281464	-5097643
2003	2380000	198333	309400	0	25270	799514	28.7	229586	762589	6378545	445	1850000	531240	-231349	-5120330
2004	2181667	198333	283617	0	26533	823283	30.4	250596	759079	6444420	455	1905000	579856	-179223	-5135884
2005	1983333	198333	257833	0	27860	849214	32.3	273998	758025	6502635	465	1965000	634006	-124018	-5145408
2006	1785000	198333	232050	0	29253	891566	34.2	304923	764559	6554597	488	2063000	705563	-58996	-5149418
2007	1586667	198333	206267	0	30715	913137	36.3	331039	766354	6600689	513	2166000	785238	18884	-5148282
2008	1388333	198333	180483	0	32251	912955	38.4	350831	761899	6641241	538	2275000	874239	112340	-5142303
2009	1190000	198333	154700	0	33864	905803	40.7	368968	755864	6676844	565	2388000	972722	216858	-5132088
2010	991667	198333	128917	0	35557	907931	43.2	392024	754831	6708308	593	2509000	1083331	328499	-5118395
2011	793333	198333	103133	0	37335	972654	45.8	445169	783970	6737227	623	2633000	1205083	421113	-5102861
2012	595000	198333	77350	0	39201	1041580	48.5	505318	820202	6764001	654	2765000	1341427	521225	-5085847
2013	396667	198333	51567	0	41161	1113437	51.4	572590	863651	6788951	687	2903000	1492880	629229	-5067669
2014	198333	198333	25783	0	43219	1189252	54.5	648273	915609	6812358	721	3048000	1661494	745885	-5048601

CAPITAL COST HYDRO ($)	5950000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	9%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE

	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	5950000	198333	535500	0	10500	367344	10.0	36608	780941	716460	215	850000	84706	-696234	-638747
1986	5751667	198333	517650	0	11025	391114	10.5	40925	767933	1362814	230	905000	94697	-673237	-1205397
1987	5553333	198333	499800	0	11576	414883	11.0	45583	755292	1946038	245	960000	105474	-649818	-1707176
1988	5355000	198333	481950	0	12155	438652	11.5	50604	743042	2472428	255	1015000	117093	-625949	-2150614
1989	5156667	198333	464100	0	12763	462422	12.1	56013	731210	2947664	270	1070000	129610	-601600	-2541613
1990	4958333	198333	446250	0	13401	486191	12.7	61837	719822	3376870	285	1125000	143086	-576736	-2885502
1991	4760000	198333	428400	0	14071	509960	13.4	68103	708908	3764667	300	1180000	157585	-551323	-3187094
1992	4561667	198333	410550	0	14775	535890	14.0	75145	698803	4115372	315	1240000	173878	-524925	-3450536
1993	4363333	198333	392700	0	15513	559660	14.7	82402	688948	4432583	330	1295000	190670	-498279	-3679957
1994	4165000	198333	374850	0	16289	581268	15.5	89862	679335	4719542	340	1345000	207933	-471402	-3879083
1995	3966667	198333	357000	0	17103	607198	16.2	98565	671001	4979577	355	1405000	228069	-442932	-4050733
1996	3768333	198333	339150	0	17959	630968	17.0	107544	662986	5215291	370	1460000	248847	-414139	-4197974
1997	3570000	198333	321300	0	18856	654737	17.9	117175	655665	5429155	380	1515000	271132	-384533	-4323401
1998	3371667	198333	303450	0	19799	678507	18.8	127501	649083	5623391	395	1570000	295024	-354059	-4429351
1999	3173333	198333	285600	0	20789	702276	19.7	138565	643288	5799998	405	1625000	320627	-322661	-4517934
2000	2975000	198333	267750	0	21829	728206	20.7	150866	638778	5960887	415	1685000	349089	-289689	-4590898
2001	2776667	198333	249900	0	22920	751975	21.8	163580	634733	6107557	425	1740000	378508	-256225	-4650105
2002	2578333	198333	232050	0	24066	775745	22.8	177188	631637	6241460	435	1795000	409996	-221641	-4697091
2003	2380000	198333	214200	0	25270	799514	24.0	191748	629551	6363901	445	1850000	443687	-185864	-4733240
2004	2181667	198333	196350	0	26533	823283	25.2	207321	628537	6476051	455	1905000	479721	-148816	-4759793
2005	1983333	198333	178500	0	27860	849214	26.4	224543	629236	6579056	465	1965000	519572	-109664	-4777745
2006	1785000	198333	160650	0	29253	891566	27.8	247529	635765	6674536	488	2063000	572759	-63006	-4787208
2007	1586667	198333	142800	0	30715	913137	29.2	266194	638042	6762447	513	2166000	631423	-6620	-4788120
2008	1388333	198333	124950	0	32251	912955	30.6	279448	634982	6842712	538	2275000	696358	61376	-4780361
2009	1190000	198333	107100	0	33864	905803	32.1	291121	630418	6915820	565	2388000	767493	137075	-4764465
2010	991667	198333	89250	0	35557	907931	33.7	306395	629536	6982798	593	2509000	846701	217166	-4741360
2011	793333	198333	71400	0	37335	972654	35.4	344649	651717	7046410	623	2633000	932974	281257	-4713907
2012	595000	198333	53550	0	39201	1041580	37.2	387526	678610	7107179	654	2765000	1028735	350124	-4682554
2013	396667	198333	35700	0	41161	1113437	39.1	434974	710169	7165523	687	2903000	1134082	423914	-4647728
2014	198333	198333	17850	0	43219	1189252	41.0	487821	747224	7221842	721	3048000	1250264	503040	-4609813

CAPITAL COST HYDRO ($)	5950000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	9%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILLION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE JEAN D'OR PRAIRIE

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	5950000	198333	535500	0	10500	367347	10.0	36608	780941	716460	215	850000	84706	-696235	-638747
1986	5751667	198333	517650	0	11025	388674	10.5	40670	767678	1362599	230	905000	94697	-672981	-1205182
1987	5553333	198333	499800	0	11576	410000	11.0	45046	754756	1945409	245	960000	105474	-649282	-1706547
1988	5355000	198333	481950	0	12155	442551	11.5	51054	743492	2472118	255	1015000	117093	-626399	-2150304
1989	5156667	198333	464100	0	12763	463878	12.1	56190	731386	2947468	270	1070000	129610	-601776	-2541417
1990	4958333	198333	446250	0	13401	485204	12.7	61712	719696	3376600	285	1125000	143086	-576610	-2885231
1991	4760000	198333	428400	0	14071	506531	13.4	67645	708450	3764146	300	1180000	157585	-550865	-3186573
1992	4561667	198333	410550	0	14775	532857	14.0	74719	698377	4114638	315	1240000	173878	-524500	-3449802
1993	4363333	198333	392700	0	15513	554184	14.7	81595	688142	4431478	330	1295000	190670	-497472	-3678852
1994	4165000	198333	374850	0	16289	581735	15.5	89934	679407	4718466	340	1345000	207933	-471474	-3878007
1995	3966667	198333	357000	0	17103	608061	16.2	98705	671141	4978556	355	1405000	228069	-443072	-4049712
1996	3768333	198333	339150	0	17959	629388	17.0	107275	662717	5214175	370	1460000	248847	-413870	-4196858
1997	3570000	198333	321300	0	18856	661939	17.9	118464	656954	5428459	380	1515000	271132	-385822	-4322704
1998	3371667	198333	303450	0	19799	683265	18.8	128395	649977	5622962	395	1570000	295024	-354953	-4428923
1999	3173333	198333	285600	0	20789	715816	19.7	141237	645960	5800303	405	1625000	320627	-325332	-4518239
2000	2975000	198333	267750	0	21829	753367	20.7	156079	643991	5962505	415	1685000	349089	-294901	-4592516
2001	2776667	198333	249900	0	22920	785919	21.8	170964	642117	6110881	425	1740000	378508	-263609	-4653429
2002	2578333	198333	232050	0	24066	818470	22.8	186947	641396	6246853	435	1795000	409996	-231400	-4702484
2003	2380000	198333	214200	0	25270	851021	24.0	204101	641904	6371696	445	1850000	443687	-198217	-4741035
2004	2181667	198333	196350	0	26533	883572	25.2	222503	643719	6486556	455	1905000	479721	-163998	-4770297
2005	1983333	198333	178500	0	27860	921123	26.4	243557	648250	6592673	465	1965000	519572	-128678	-4791362
2006	1785000	198333	160650	0	29253	967490	27.8	268608	656844	6691319	488	2063000	572759	-84085	-4803990
2007	1586667	198333	142800	0	30715	1014368	29.2	295704	667552	6783295	513	2166000	631423	-36130	-4808968
2008	1388333	198333	124950	0	32251	1067245	30.6	326674	682209	6869530	538	2275000	696358	14149	-4807179
2009	1190000	198333	107100	0	33864	1119633	32.1	359845	699142	6950608	565	2388000	767493	68351	-4799253
2010	991667	198333	89250	0	35557	1179792	33.7	398139	721279	7027346	593	2509000	846701	125422	-4785909
2011	793333	198333	71400	0	37335	1249138	35.4	442618	749686	7100522	623	2633000	932974	183288	-4768019
2012	595000	198333	53550	0	39201	1324662	37.2	492848	783933	7170722	654	2765000	1028735	244802	-4746097
2013	396667	198333	35700	0	41161	1402542	39.1	547915	823110	7238344	687	2903000	1134082	310972	-4720549
2014	198333	198333	17850	0	43219	1485601	41.0	609381	868784	7303825	721	3048000	1250264	381480	-4691797

14-Mar-85

CAPITAL COST HYDRO ($)	5950000
LIFE (YEARS)	30
RETURN/DISCOUNT RATE	13%
INFLATION RATE	5%
FUEL ESCALATION RATE	5%

VERMILION FALLS HYDRO STUDY
500 kW INSTALLATION
TO SERVE JOHN D'OR PRAIRIE

** HYDRO AVAILABLE ALL YEAR

*	HYDRO DEVELOPMENT										* LOAD DATA		* DIESEL *	HYDRO SAVINGS	
YEAR	RATE BASE ($)	DEPREC. ($)	RETURN ($)	PLANT O & M ($)	TRANS. O & M ($)	DIESEL ENERGY (kW.h)	DIESEL RATE (C/kW.h)	DIESEL COST ($)	TOTAL COST (HYDRO & DIESEL) ($)	HYDRO CUMULATIVE PRESENT COST ($)	ANNUAL PEAK (kW)	TOTAL ENERGY (kW.h)	COST TO SUPPLY ENERGY BY DIESEL ($)	SAVINGS ($)	SAVINGS CUMULATIVE PRESENT WORTH ($)
1985	5950000	198333	773500	0	10500	0	10.0	0	982333	869322	215	850000	84706	-897627	-794360
1986	5751667	198333	747717	0	11025	0	10.5	0	957075	1618852	230	905000	94697	-862378	-1469729
1987	5553333	198333	721933	0	11576	0	11.0	0	931843	2264666	245	960000	105474	-826369	-2042444
1988	5355000	198333	696150	0	12155	0	11.5	0	906638	2820724	255	1015000	117093	-789545	-2526687
1989	5156667	198333	670367	0	12763	0	12.1	0	881463	3299147	270	1070000	129610	-751853	-2934762
1990	4958333	198333	644583	0	13401	0	12.7	0	856318	3710452	285	1125000	143086	-713232	-3277341
1991	4760000	198333	618800	0	14071	0	13.4	0	831204	4063764	300	1180000	157585	-673619	-3563670
1992	4561667	198333	593017	0	14775	0	14.0	0	806125	4366996	315	1240000	173878	-632247	-3801496
1993	4363333	198333	567233	0	15513	0	14.7	0	781080	4627005	330	1295000	190670	-590410	-3998034
1994	4165000	198333	541450	0	16289	0	15.5	0	756072	4849735	340	1345000	207933	-548139	-4159510
1995	3966667	198333	515667	0	17103	0	16.2	0	731103	5040332	355	1405000	228069	-503034	-4290650
1996	3768333	198333	489883	0	17959	0	17.0	0	706175	5203251	370	1460000	248847	-457328	-4396158
1997	3570000	198333	464100	0	18856	0	17.9	0	681290	5342346	380	1515000	271132	-410157	-4479898
1998	3371667	198333	438317	0	19799	0	18.8	0	656449	5460951	395	1570000	295024	-361425	-4545199
1999	3173333	198333	412533	0	20789	0	19.7	0	631656	5561947	405	1625000	320627	-311029	-4594929
2000	2975000	198333	386750	0	21829	0	20.7	0	606912	5647823	415	1685000	349089	-257823	-4631410
2001	2776667	198333	360967	0	22920	0	21.8	0	582220	5720728	425	1740000	378508	-203712	-4656919
2002	2578333	198333	335183	0	24066	0	22.8	0	557583	5782515	435	1795000	409996	-147587	-4673273
2003	2380000	198333	309400	0	25270	0	24.0	0	533003	5834783	445	1850000	443687	-89316	-4682032
2004	2181667	198333	283617	0	26533	0	25.2	0	508483	5878910	455	1905000	479721	-28762	-4684528
2005	1983333	198333	257833	0	27860	0	26.4	0	484026	5916083	465	1965000	519572	35546	-4681798
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2009	1190000	198333	154700	0	33864	78016	32.1	25074	411971	6015804	565	2388000	767493	355522	-4631402
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2011	793333	198333	103133	0	37335	147584	35.4	52295	391096	6046933	623	2633000	932974	541878	-4592823
2012	595000	198333	77350	0	39201	185167	37.2	68892	383777	6059461	654	2765000	1028735	644958	-4571769
2013	396667	198333	51567	0	41161	224156	39.1	87569	378630	6070399	687	2903000	1134082	755452	-4549945
2014	198333	198333	25783	0	43219	265591	41.0	108943	376279	6080019	721	3048000	1250264	873985	-4527601

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